ATRT-01 S3 and ATRT-01B S3

SINGLE PHASE TRANSFORMER TURNS-RATIO METERS

USER'S MANUAL

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SAFETY SUMMARY

This manual applies to both the ATRT-01 S3 and ATRT-01B S3 current transformer turns-ratio meters. The operating procedures are virtually the same for both models, and any differences are clearly described where applicable.

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from procedures described in this User's Manual may create one or more safety hazards, damage the ATRT-01/01B S3, damage the test transformer, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the ATRT-01/01B S3.

SAFETY WARNINGS AND CAUTIONS

The ATRT-01/01B S3 shall be used only by **trained operators**. All transformers under test shall be **off-line** and **fully isolated**. Do not perform test procedures or service unless another person is also present who is capable of rendering aid and resuscitation.

DO NOT MODIFY TEST EQUIPMENT

To avoid the risk of introducing additional or unknown hazards, do not install substitute parts or perform any unauthorized modification to any ATRT-01/01B S3 test unit. To ensure that all designed safety features are maintained, it is highly recommended that repairs be performed only by Vanguard Instruments Company factory personnel or by an authorized repair service provider. Unauthorized modifications can cause safety hazards and will void the manufacturer's warranty.

WARNING

Do not remove test leads during a test. Failure to heed this warning can result in electrical shock to personnel and damage to the equipment.

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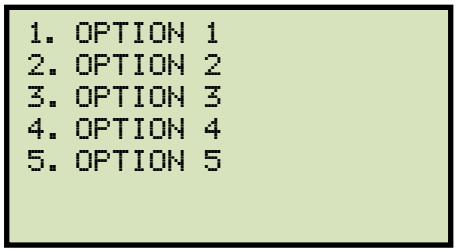
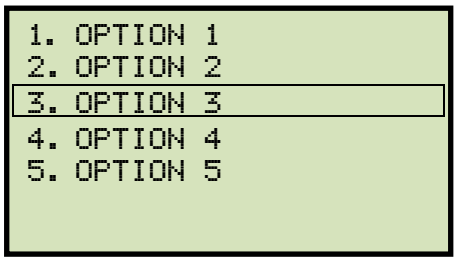
CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- The general term "ATRT" is used in this manual to refer to the ATRT-01 S3 and ATRT-01B S3.
- A key, switch, or knob on the ATRT is indicated as **[KEY], [SWITCH], [KNOB]**.
- Menu names are referenced as "MENU NAME"
- ATRT screen output is shown as:



- When instructions are provided, the menu item that should be selected is outlined with a rectangle as shown below (option 3 should be selected):



- Warning messages are indicated as:

Warning message

WARNING

- Important notes are indicated as:

Note details

NOTE

1.0 INTRODUCTION

1.1 General Description and Features

The ATRT-01 S3 is Vanguard's fourth generation, micro-processor based, single phase, automatic transformer turns-ratio tester. This portable test unit is available in two models, the ATRT-01 S3 (line power only), and the ATRT-01B S3 (rechargeable-battery powered).

The ATRT-01 S3 uses the IEEE C57.12.90 measuring method to determine the transformer turns-ratio. The transformer turns-ratio is determined by precisely measuring the voltages across the unloaded transformer windings. The ATRT-01 S3's measuring circuitry self adjusts before each measurement to ensure turns-ratio accuracy. Two selectable test voltages, 4Vac and 40Vac, offer flexibility in testing different types of transformers.

The ATR-01 S3 can measure turns-ratios ranging from 0.8 to 15,000 and can be used to test voltage regulators, power transformers, current transformers (CT), and potential transformers (PT). The ATRT-01 S3 also measures and displays transformer-winding excitation current, winding polarity, and winding phase angle. Test results are displayed on a back-lit LCD screen (128 x 64 pixels) that is viewable in bright sunlight and low-light conditions.

In addition to measuring a transformer's turns-ratio, the transformer's name plate voltages can also be entered, and the ATRT-01 S3 will then display the turns-ratio percentage error. This convenient feature eliminates any user-calculation errors when testing transformers.

When testing a 3-phase transformer, the ATRT-01 S3 provides connection information (H and X test leads to the transformer bushings) for phase A, B and C tests. The three phase test results (turns-ratio, excitation current, winding polarity, phase-angle, and percentage error) are displayed on the LCD screen.

User Interface

The ATRT-01 S3 features a back-lit LCD screen (128 x 64 pixels) that is viewable in direct sunlight and low-light levels. A rugged 16-key membrane keypad is used to enter test information and to operate the unit.

Test Record Storage

The ATRT-01 S3 can store 128 records of 33 readings internally, and up to 999 test records on an external USB Flash drive. Test records can be recalled using the included Transformer Analysis PC software.

Computer Interface

A Windows®-based (XP/Vista/7) Transformer Analysis Software is provided with each unit and can be used to remotely control the ATRT-01 S3 via the RS-232C port. Using the Transformer Analysis software, the user can retrieve test records (from the ATRT-01 S3's memory or a USB Flash drive), analyze test results, and print test results on a desktop printer. Test results are automatically exported to PDF, Excel, and XML formats.

Battery Power for Exceptional Portability

The ATRT-01B S3 is powered by a 6-volt, 7 ampere-hour, lead acid battery. This high capacity battery, coupled with the ATRT-01B S3's low power consuming circuitry, allows the unit to be used continuously for up to 4 hours per charge. A built-in charger allows the unit to be used during charging.

1.2 Technical Specifications

1.2.1. ATRT-01 S3 Technical Specifications

Table 1. ATRT-01 S3 Technical Specifications

TYPE	Transformer Turns Ratio Tester
PHYSICAL SPECIFICATIONS	Dimensions: 12" x 10" x 8" (30.4 cm x 25.4 cm x 20.3 cm) Weight: 8 lbs (3.6 Kg)
INPUT POWER	120 or 240 Vac (Selectable), 50/60 Hz
MEASURING METHOD	ANSI/IEEE C57.12.90
RATIO MEASURING RANGE	0.8 - 15,000 (5 digit resolution)
TURNS-RATIO ACCURACY	40 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (1%) 4 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (2%)
TEST VOLTAGE	4 Vac @ 1.0A, 40 Vac @ 0.6A
PHASE ANGLE MEASUREMENT	0 - 360 degrees, Accuracy ±0.2 degree (±1 digit)
POLARITY READING	In-Phase or Out-of-Phase indication
EXCITATION CURRENT READING RANGE	0-2 Amperes, Accuracy: 2% of reading (±1 mA)
DISPLAY	Back-lit LCD (128 x 64 pixels), viewable in direct sunlight and low light levels
COMPUTER INTERFACE	RS-232C
PC SOFTWARE	Windows XP/Vista/7 Transformer Analysis Software (included with purchase)
INTERNAL TEST RECORD STORAGE	128 records of 33 readings
EXTERNAL TEST RECORD STORAGE	Up to 999 test records on external USB Flash drive.
SAFETY	Designed to meet IEC 61010 (1995), UL 61010A-1, and CSA-C22.2 standards
ENVIRONMENT	Operating: -10ºC to 50ºC (15ºF to +122ºF) Storage: (-30ºC to 70ºC (-22ºF to +158ºF)
HUMIDITY (MAX)	90% RH @ 40˚ C (104˚ F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to full safety specifications
CABLES	One 15 ft. (4.6m) Single phase cable, one power cord, one cable bag
OPTIONS	Transportation Case (Can hold unit and cables)
WARRANTY	One year on parts and labor

NOTE

The above specifications are valid at nominal operating voltage and at a temperature of 25°C (77°F). Specifications may change without prior notice.

1.2.2. ATRT-01B S3 Technical Specifications

Table 2. ATRT-01B S3 Technical Specifications

TYPE	Transformer Turns Ratio Tester
PHYSICAL SPECIFICATIONS	Dimensions: 12" x 10" x 8" (30.4 cm x 25.4 cm x 20.3 cm) Weight: 9 lbs (4.3 Kg)
INPUT POWER	90 to 240 Vac, 50/60 Hz Battery: SLA battery delivering up to 4 hours of continuous operation per charge.
MEASURING METHOD	ANSI/IEEE C57.12.90
RATIO MEASURING RANGE	0.8 - 15,000 (5 digit resolution)
TURNS-RATIO ACCURACY	40 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (1%) 4 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (2%)
TEST VOLTAGE	4 Vac @ 500mA, 40 Vac @ 70mA
PHASE ANGLE MEASUREMENT	0 - 360 degrees, Accuracy ±0.2 degree (±1 digit)
POLARITY READING	In-Phase or Out-of-Phase indication
EXCITATION CURRENT READING RANGE	0-2 Amperes, Accuracy: 2% of reading (±1 mA)
DISPLAY	Back-lit LCD (128 x 64 pixels), viewable in direct sunlight and low light levels
COMPUTER INTERFACE	RS-232C
PC SOFTWARE	Windows XP/Vista/7 Transformer Analysis Software (included with purchase)
INTERNAL TEST RECORD STORAGE	128 records of 33 readings
EXTERNAL TEST RECORD STORAGE	Up to 999 test records on external USB Flash drive.
SAFETY	Designed to meet IEC 61010 (1995), UL 61010A-1, and CSA-C22.2 standards
ENVIRONMENT	Operating: -10ºC to 50ºC (15ºF to +122ºF) Storage: (-30ºC to 70ºC (-22ºF to +158ºF)
HUMIDITY (MAX)	90% RH @ 40˚ C (104˚ F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to full safety specifications
CABLES	One 15 ft. (4.6m) Single phase cable, one power cord, one cable bag
OPTIONS	Transportation Case (Can hold unit and cables)
WARRANTY	One year on parts and labor

NOTE

The above specifications are valid at nominal operating voltage and at a temperature of 25°C (77°F). Specifications may change without prior notice.

1.2.3. Controls and Indicators

The ATRT-01 S3 and ATRT-01B S3 controls and indicators are shown in Figure 1 and Figure 2, respectively. A leader line with an index number points to each control and indicator, which is cross-referenced to a functional description in the corresponding table. The purpose of the controls and indicators may seem obvious, but users should familiarize themselves with them before using the ATRT. Accidental misuse of the controls will usually cause no serious harm. Users should also familiarize themselves with the safety summary information found on the front page of this User's Manual.

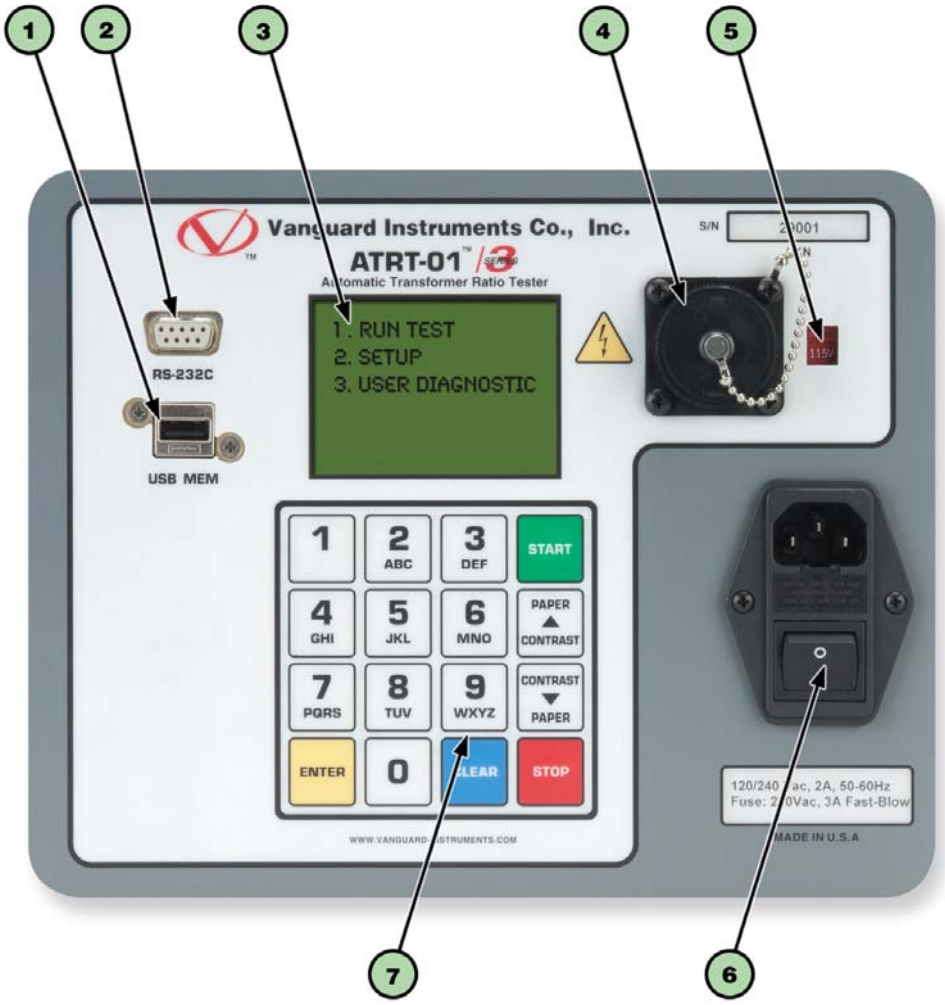


Figure 1. ATRT-01 S3 Controls and Indicators

Table 3. Functional Descriptions of ATRT-01 S3 Controls and Indicators

Item Number	Panel Markings	Functional Description
1	USB MEM	USB Flash drive interface
2	RS-232C	RS-232C computer interface port
3		Back-lit LCD screen (128 x 64 pixels), viewable in direct sunlight and low light levels
4		H and X lead connector (16-pin male).
5		Voltage selection switch
6	120/240 Vac, 2A, 50-60Hz Fuse: 250Vac, 3A Fast-Blow	Input power connector and fused power switch with third-wire safety ground.
7		Rugged alpha-numeric keypad

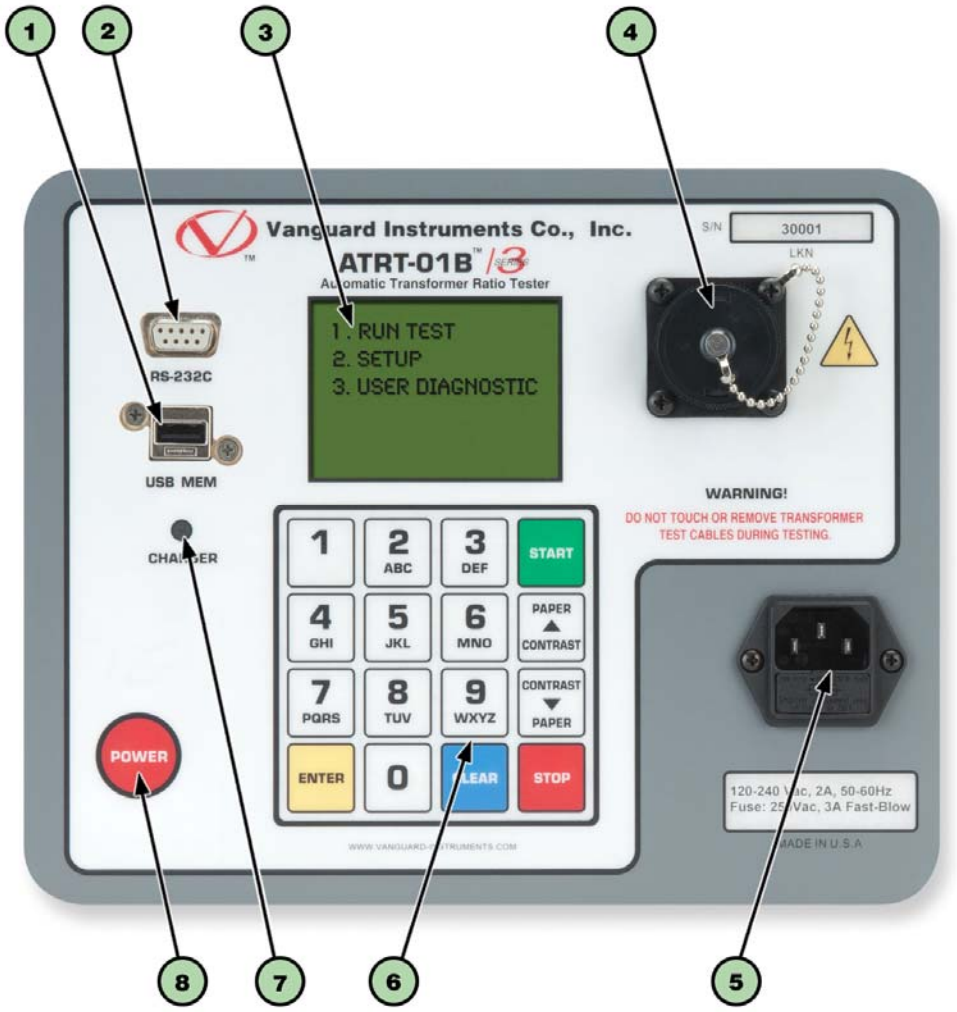


Figure 2. ATRT-01B S3 Controls and Indicators

Table 4. Functional Descriptions of ATRT-01B S3 Controls and Indicators

Item Number	Panel Markings	Functional Description
1	USB MEM	USB Flash drive interface
2	RS-232C	RS-232C computer interface port
3		Back-lit LCD screen (128 x 64 pixels), viewable in bright sunlight and low light levels
4		H and X lead connector (16-pin male).
5	120-240 Vac, 2A, 50-60Hz Fuse: 250Vac, 3A Fast-Blow	Input power connector
6		Rugged alpha-numeric keypad
7	CHARGER	Battery charging indicator. LED lights up when battery is being charged.
8	POWER	Power switch

2.0 PRE-TEST SETUP

2.1 ATRT-01 S3 Operating Voltage

The ATRT-01 S3 can be operated from 120 Vac or 240 Vac. The power voltage can be set using the voltage selector switch on the front panel (see Figure 1, item #5)

2.2 ATRT-01B S3 Operating Power

The ATRT-01B S3 is powered by a rechargeable (6 Vdc / 7 AH) sealed lead acid gel battery. The unit can operate continuously for up to 6 hours between charges. It can also be used while charging. Plugging the ATRT-01B S3 into an ac power outlet after the battery is fully charged will not damage the battery.

NOTES

- It is recommended that the ATRT-01B S3 be plugged into an ac outlet when it is not in use.
- The ATRT-01B S3 uses the Genesis model NP7-6 battery. It can also be replaced with the Panasonic model LC-R122R2PU battery.

2.3 LCD Screen Contrast Control

To increase the LCD screen contrast, press and hold the **[∧ Contrast]** key for two seconds. Release the button when the desired contrast level has been reached.

To decrease the LCD screen contrast, press and hold the **[∨ Contrast]** key for two seconds. Release the button when the desired contrast level has been reached.

For the ATRT-01B S3, the back-light turns off after 30 seconds of operation to conserve power. Press any key on the keypad to re-light the back-light.

3.0 OPERATING PROCEDURES

3.1 ATRT Transformer Connection Diagrams

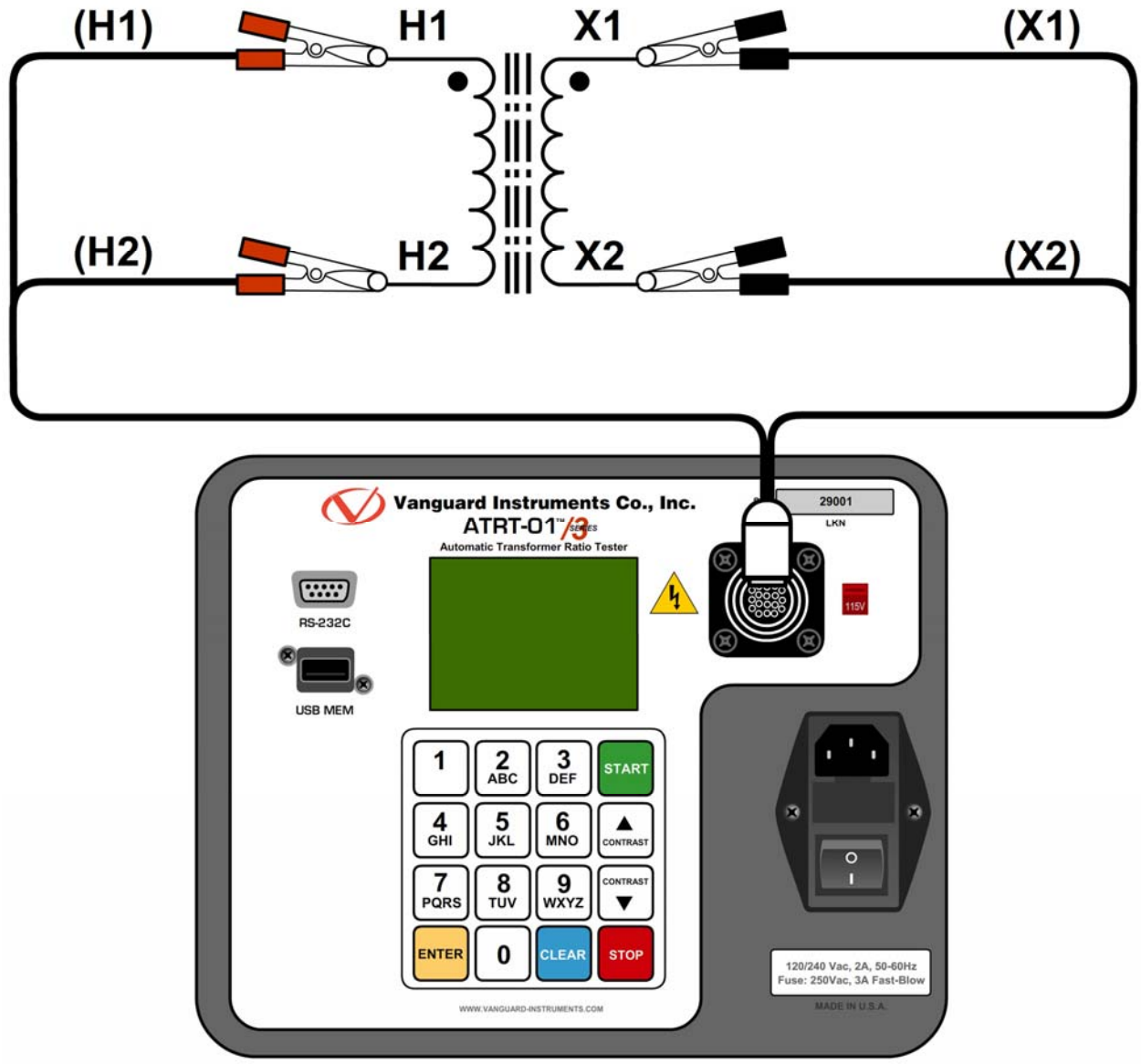


Figure 3. Typical Single-Phase Transformer Connection

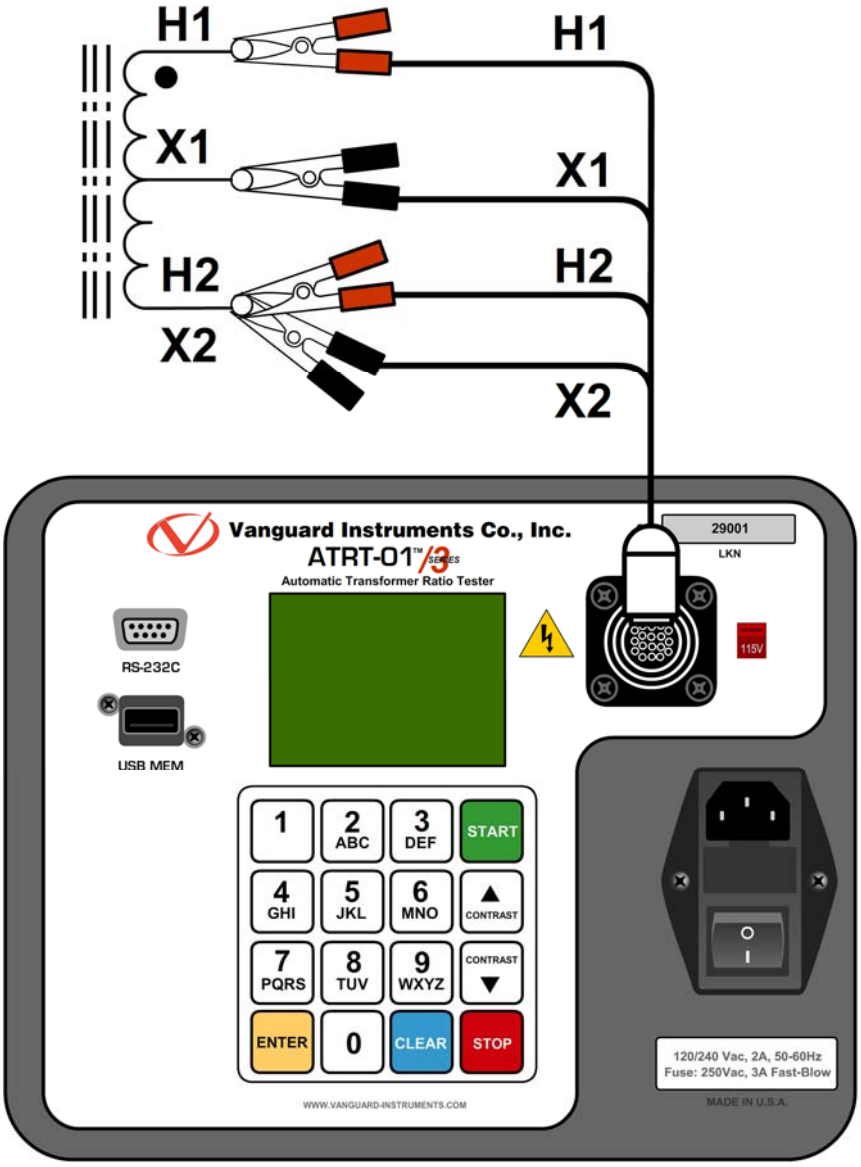


Figure 4. Typical Auto Transformer Connection

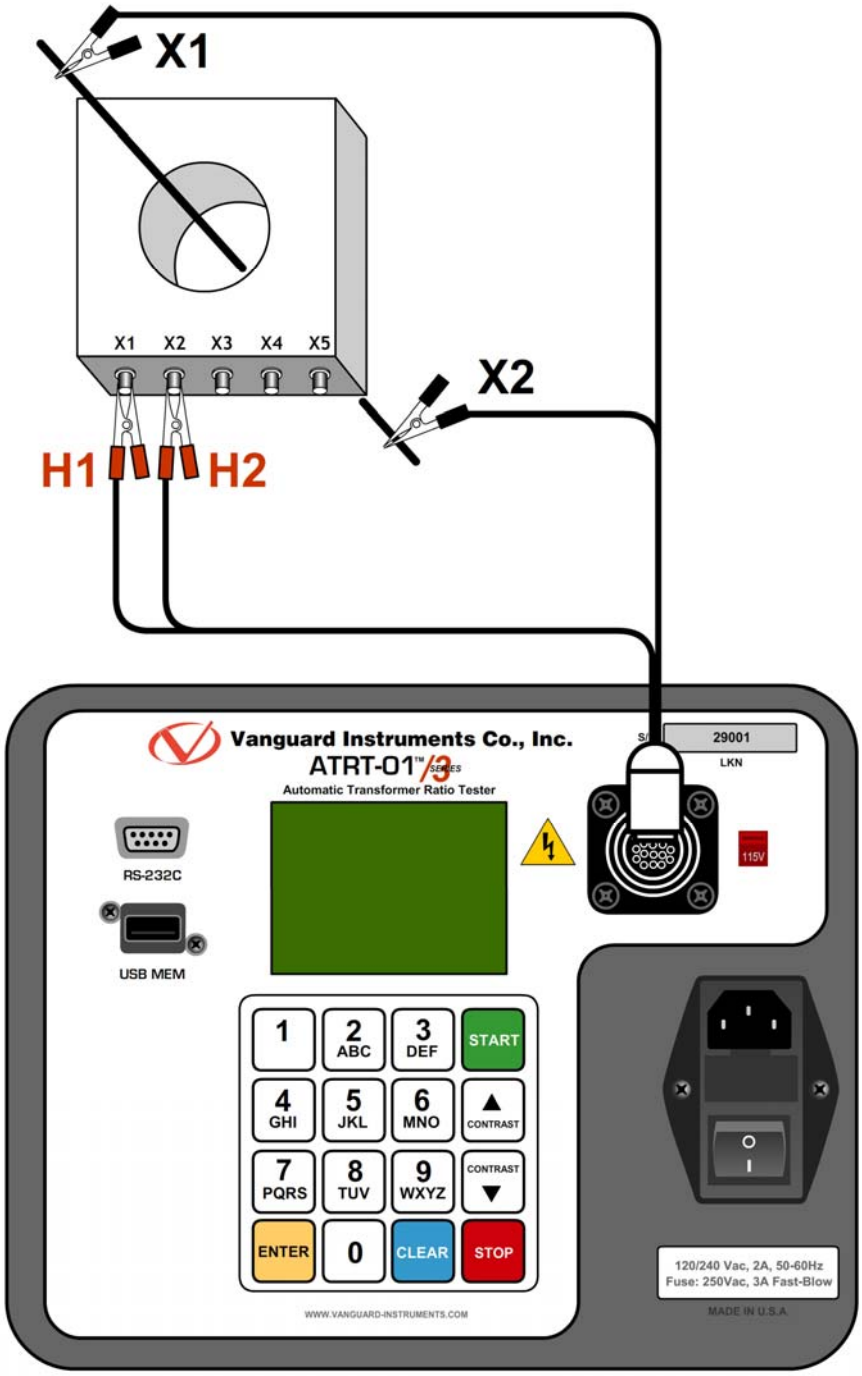


Figure 5. Typical CT Connection

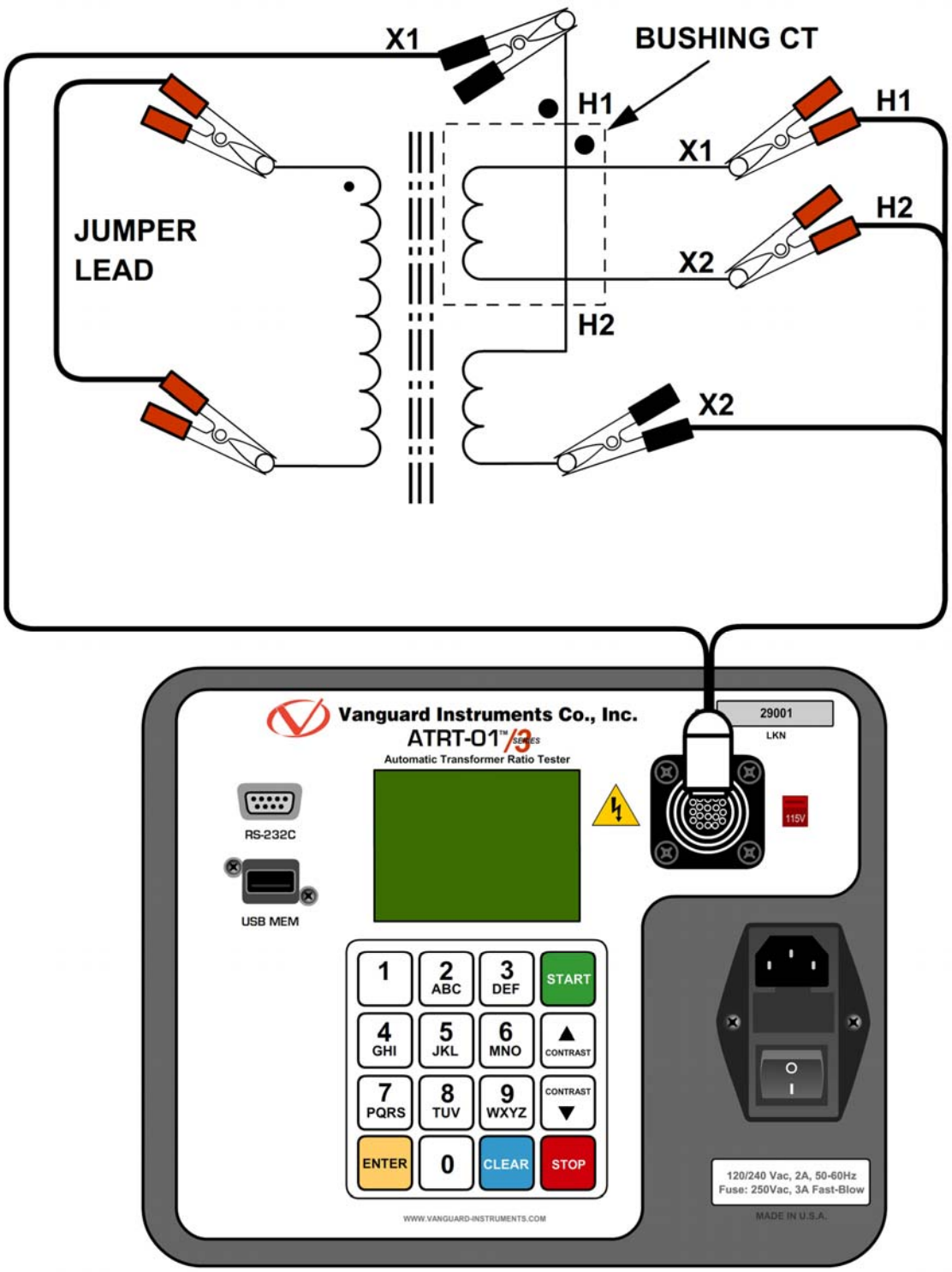
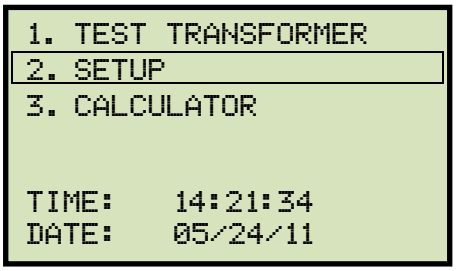


Figure 6. Typical Bushing CT Connection on a Single Transformer

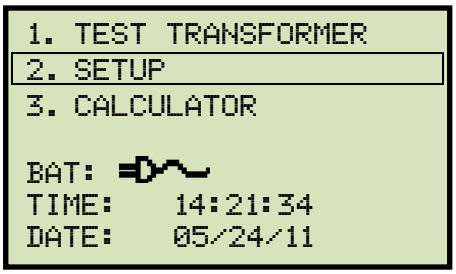
3.2 Setting the Test Voltage

The ATRT offers two test voltages, 4 Vac and 40 Vac. The unit always defaults to 40 Vac at power-on. The 4 Vac test voltage can be used in situations where the 40 Vac excitation voltage may saturate the CT's. To set the test voltage:

a. Turn on the unit and start from the " START-UP" menu:



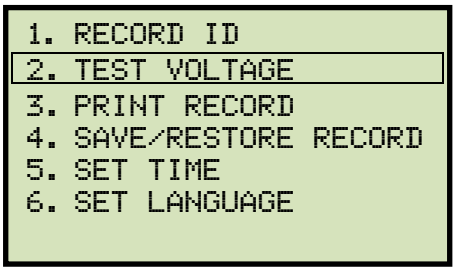
ATRT-01 S3 "START-UP" menu



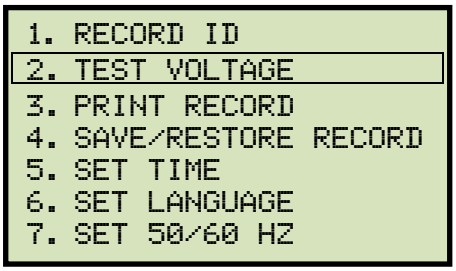
ATRT-01B S3 "START-UP" menu

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



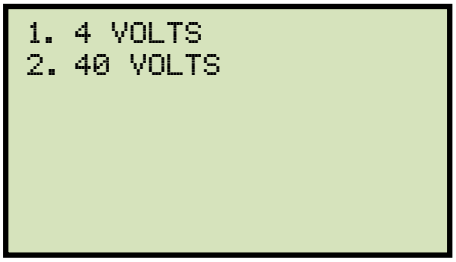
ATRT-01 S3



ATRT-01B S3

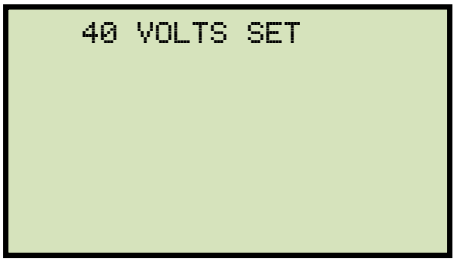
Press the **[2]** key (*TEST VOLTAGE*).

c. The following screen will be displayed:



Press the **[1]** key (*4 VOLTS*) to select 4 volts as the test voltage or press the **[2]** key (*40 VOLTS*) to select 40 volts as the test voltage.

d. The voltage will be set and the following confirmation message will be displayed:

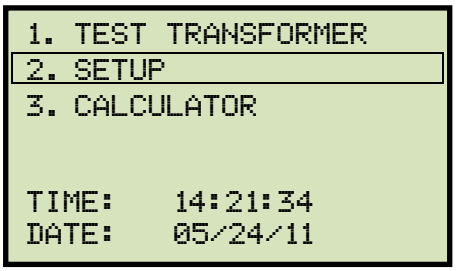


Press any key to return to the "START-UP" menu.

3.3 Setting the Date and Time

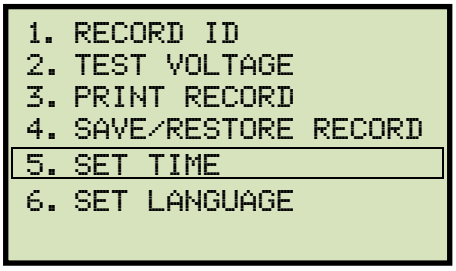
To set the date and time:

a. Start from the "START-UP" menu:



Press the **[2]** key (*SETUP*).

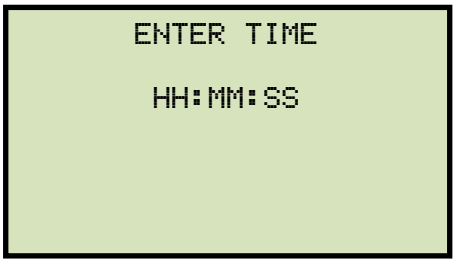
b. The following screen will be displayed:



Press the **[5]** key (*SET TIME*)

c. The following screen will be displayed:

Type in the date using the alpha-numeric keypad. The following screen will be displayed:

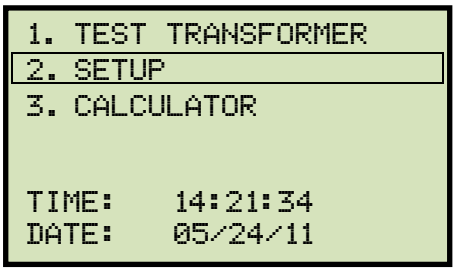


Enter the time using the alpha-numeric keypad. When the time has been entered, you will be immediately returned to the "START-UP" menu.

3.4 Setting the Interface Language

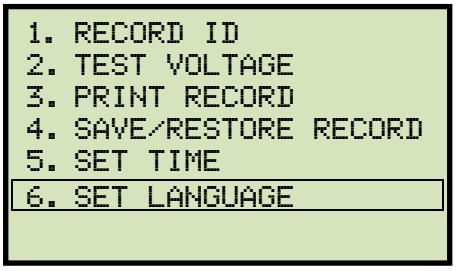
Follow the steps below to set the interface language (English, Spanish, or Turkish):

a. Start from the "START-UP" menu:



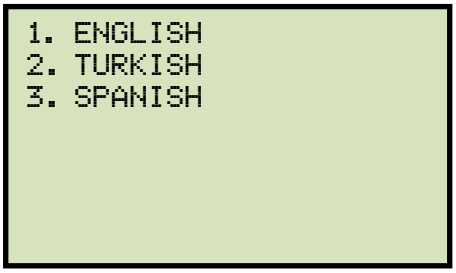
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

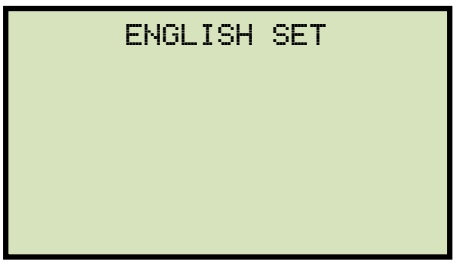


Press the **[6]** key (*SET LANGUAGE*).

c. The following screen will be displayed:



Select the preferred interface language by pressing the corresponding key on the keypad (**[1]**, **[2]**, or **[3]**). The interface language will be set and a confirmation screen will be displayed as shown below:

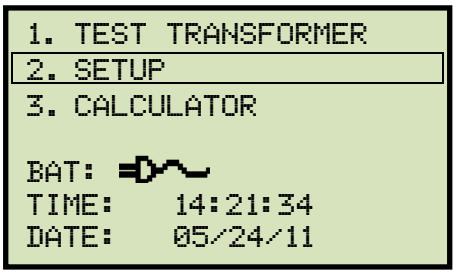


Press any key to return to the "START-UP" menu.

3.5 Setting the Frequency (ATRT-01B S3 Only)

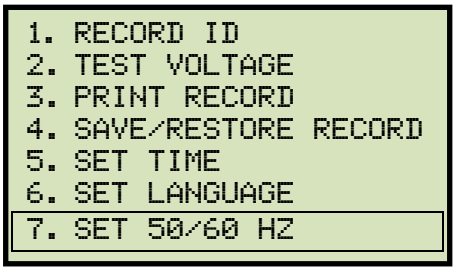
Follow the steps below to set the preferred frequency (50 or 60 Hz):

a. Start from the "START-UP" menu:



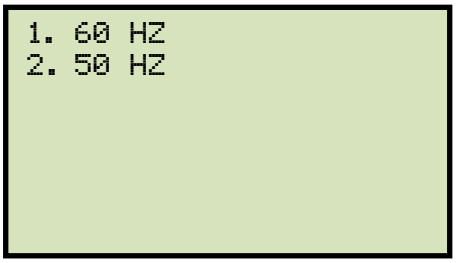
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

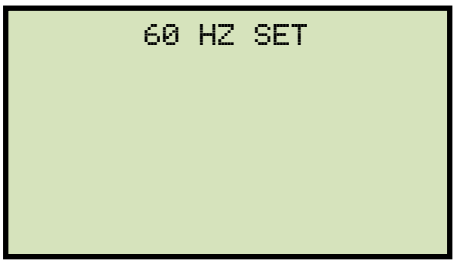


Press the **[7]** key (*SET 50/60 HZ*).

c. The following screen will be displayed:



Select the preferred frequency by pressing the corresponding key on the keypad (**[1]** or **[2]**). The frequency will be set and a confirmation screen will be displayed as shown below:



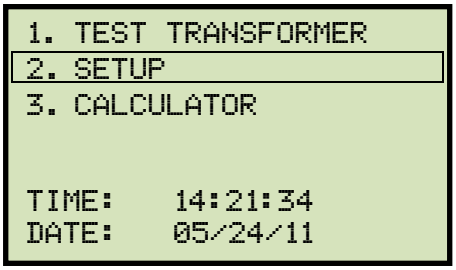
Press any key to return to the "START-UP" menu.

3.6 Performing Tests

3.6.1. Entering Test Record Header Information

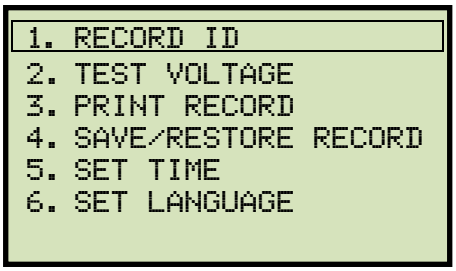
You can enter the test record header information before performing tests. The record header includes identifying information such as the company, station, circuit, manufacturer, etc. Once the header information has been set, it will apply to all subsequent test records. Follow the steps below to enter the test header information:

a. Start from the "START-UP" menu:



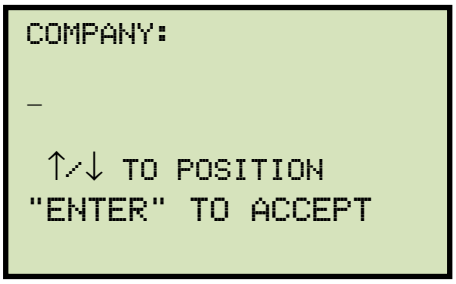
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[1]** key (*RECORD ID*).

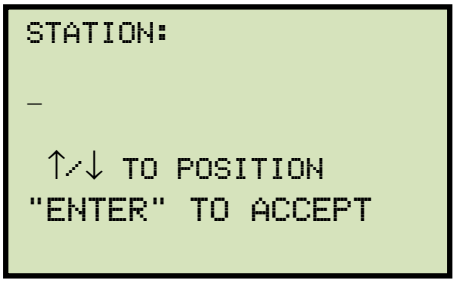
c. The following screen will be displayed:



Type the company name using the alpha-numeric keypad.

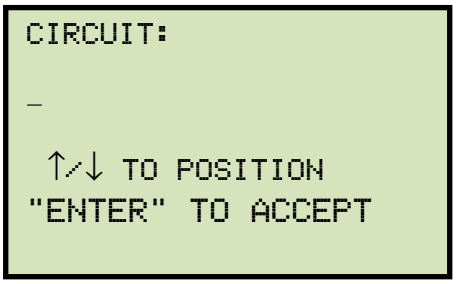
When pressing a key, the corresponding number on the key will be displayed first. Pressing the key again will display the first letter on the key. Pressing the key again will display the second letter on the key. For example, to type the letter "A", you must press the **[2]** key twice. To erase the character at the cursor position, press the **[CLEAR]** key. Press the **[Contrast ∧]** key to move to the next character. Press the **[Contrast ∨]** key to move to the previous character. Press the **[ENTER]** key when you are done typing the company name.

d. The following screen will be displayed:



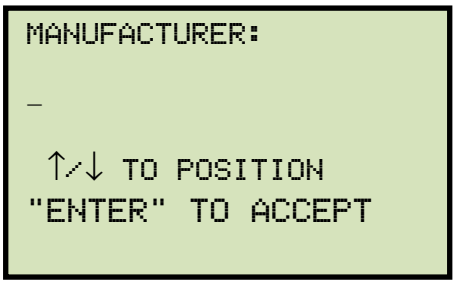
Type the station name using the alpha-numeric keypad and then press the **[ENTER]** key.

e. The following screen will be displayed:



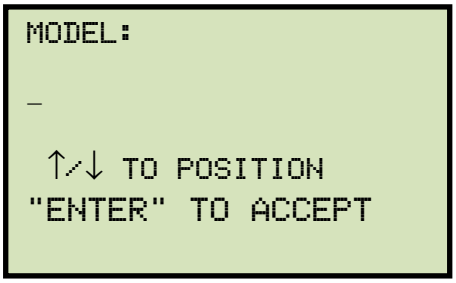
Type the circuit information using the alpha-numeric keypad and then press the **[ENTER]** key.

f. The following screen will be displayed:



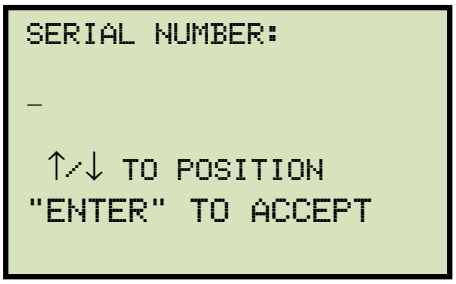
Type the manufacturer name using the alpha-numeric keypad and then press the **[ENTER]** key.

g. The following screen will be displayed:



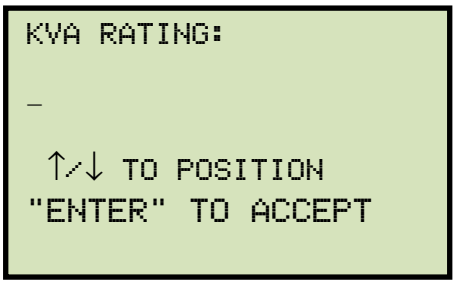
Type the transformer's model information using the alpha-numeric keypad and then press the **[ENTER]** key.

h. The following screen will be displayed:



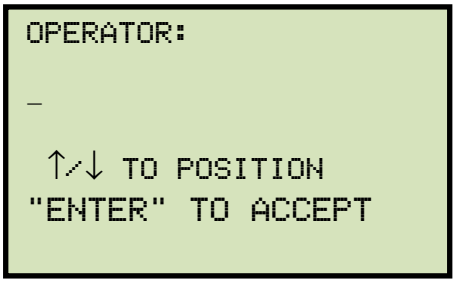
Type the transformer's serial number using the alpha-numeric keypad and then press the **[ENTER]** key.

i. The following screen will be displayed:



Type the transformer's KVA rating using the alpha-numeric keypad and then press the [**ENTER**] key.

j. The following screen will be displayed:

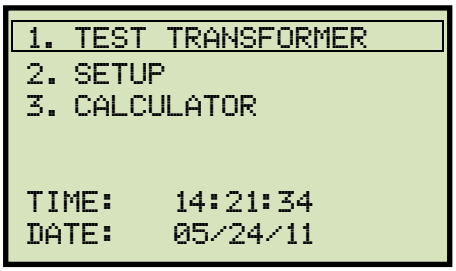


Type the operator's name using the alpha-numeric keypad and then press the **[ENTER]** key. All header information will be saved, and you will be returned to the "START-UP" menu.

3.6.2. Testing a Single Phase Transformer

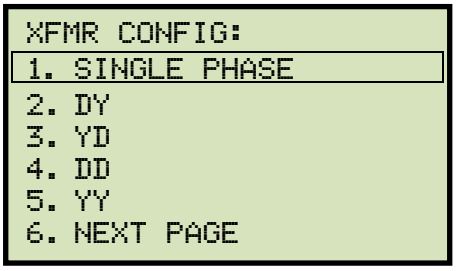
Follow the steps below to test a single phase transformer:

a. Start from the "START-UP" menu:



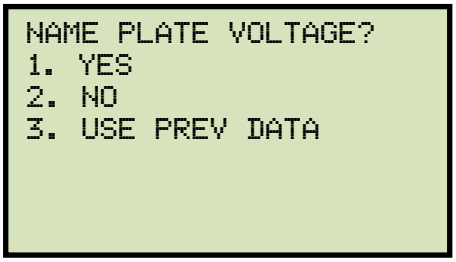
Press the **[1]** key (*TEST TRANSFORMER*).

b. The following screen will be displayed:



Press the **[1]** key (*SINGLE PHASE*).

c. The following screen will be displayed:

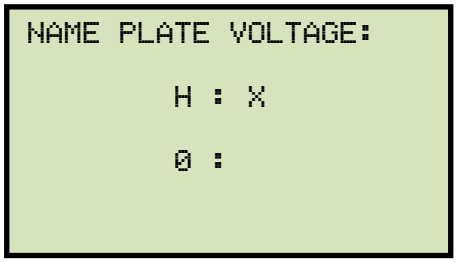


NOTE

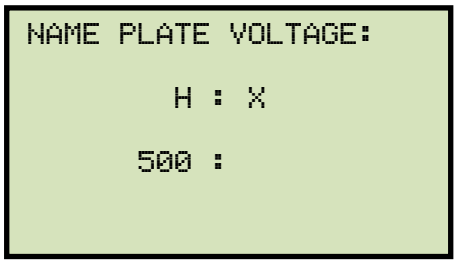
Option 3 (*USE PREV DATA*) will be listed only if you had provided name plate voltages for a previous test.

1. YES

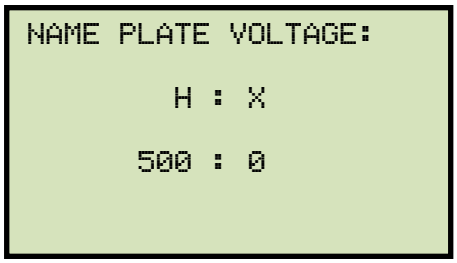
Press the **[1]** key (*YES*) if you would like to enter the transformer name plate voltage values. The following screen will be displayed:



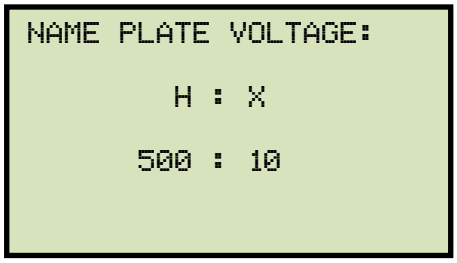
Type the H winding name plate voltage value using the numeric keypad. The screen will be updated as shown:



Press the **[ENTER]** key. The following screen will be displayed:



Type the X winding name plate voltage value using the numeric keypad. The screen will be updated as shown:



Press the **[ENTER]** key. **Continue to step d**.

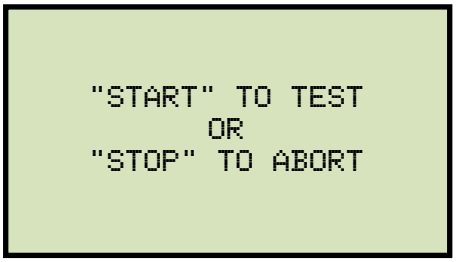
2. *NO*

   Press the **[2]** key (*NO*) if you do not want to enter the transformer name plate voltage. **Continue to step d**.

3. *USE PREV DATA*

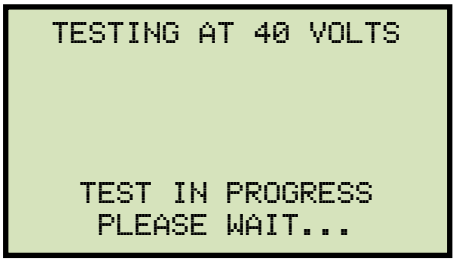
   Press the **[3]** key (*USE PREV DATA*) to use the name plate voltage values entered when performing the last test. **Continue to step d.**

d. The following screen will be displayed:

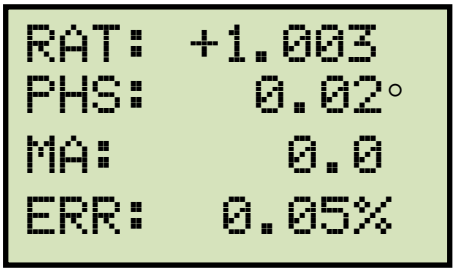


Press the **[START]** key to start the test.

e. The following screen will be displayed while the test is being performed:



The test results will be displayed on the LCD screen when testing has finished:

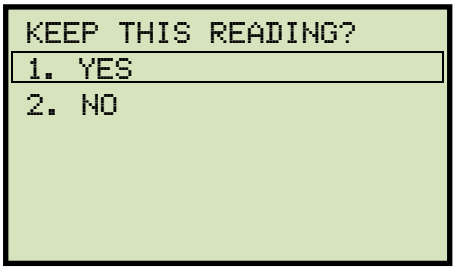


NOTE The percentage error (ERR) will be displayed only if name plate voltage values were entered.

The polarity is displayed as either a plus sign (+) for "in-phase" or a minus sign (-) for "out-of-phase".

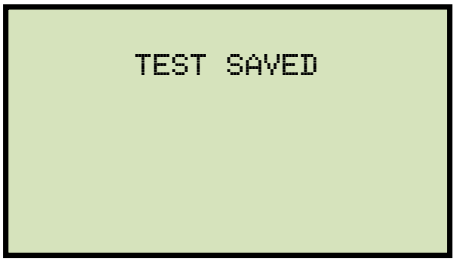
Press any key to continue.

f. The following screen will be displayed:



Press the **[1]** key (*YES*) to save the reading.

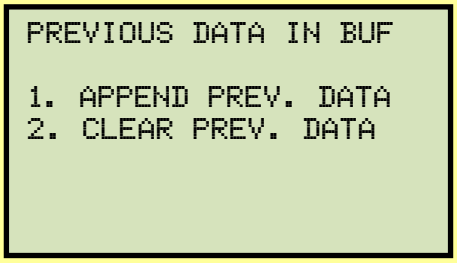
g. The following screen will be displayed:



Press any key to continue.

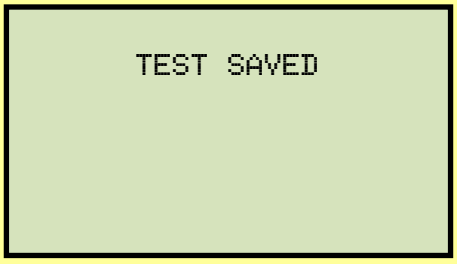
NOTE

The above screen will be displayed if there is currently no data in the unit's memory buffer. If a test was previously performed or a test record was restored from Flash EEPROM or from a Flash drive, the following screen will be displayed instead:



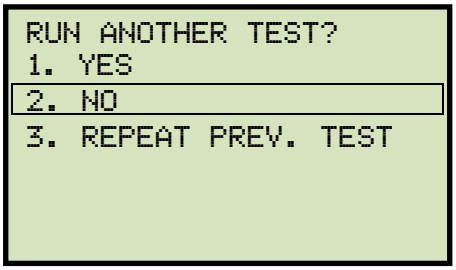
Press the **[1]** key (*APPEND PREV. DATA*) to append the data in the unit's working memory to the current test results, or press the **[2]** key (*CLEAR PREV. DATA*) to clear any previous data from the unit's memory buffer and only save the current test results.

The following screen will then be displayed:



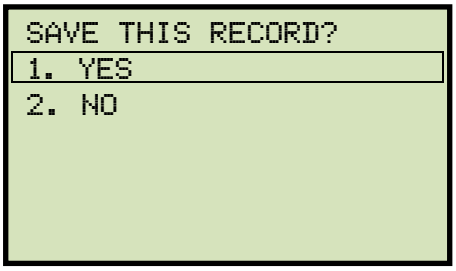
Press any key to continue.

h. The following screen will be displayed:



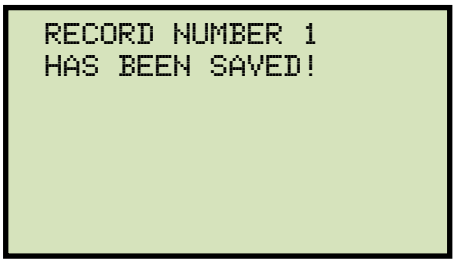
Press the **[2]** key (*NO*).

i. The following screen will be displayed:



Press the **[1]** key (*YES*) to save the test record to the unit's Flash EEPROM.

j. The test record will be saved and the following screen will be displayed:



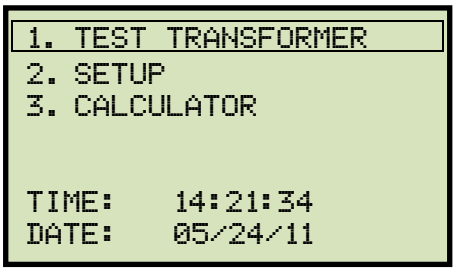
NOTE The unit will automatically assign the record number and will not over-write existing test records.

Press any key to return to the "START-UP" menu.

3.6.3. Testing a Three Phase Transformer

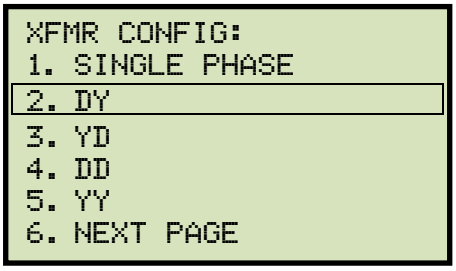
Follow the steps below to test a three phase transformer:

a. Start from the "START-UP" menu:



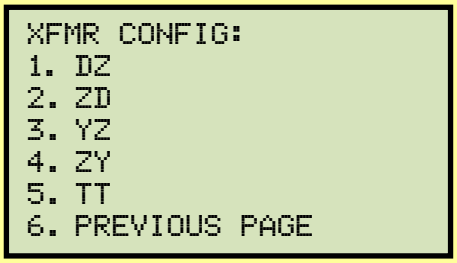
Press the **[1]** key (*TEST TRANSFORMER*).

b. The following screen will be displayed:



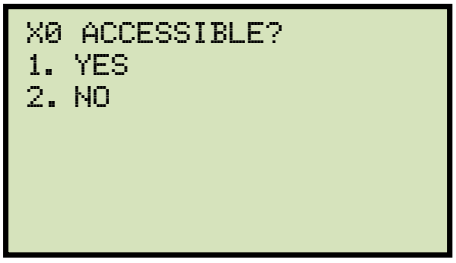
NOTE

You can press the **[6]** key (*NEXT PAGE*) to view additional transformer types. The following screen will be displayed:



Select a three-phase transformer test by pressing the corresponding key (**[2]** to **[5]**). For this example, press the **[2]** key (*Dy*) from the first page to select the Delta to Y phase transformer test.

c. The following screen will be displayed:



Press the **[1]** key (*YES*) if X0 is accessible or the **[2]** key (*NO*) if it is not accessible.

d. The following screen will be displayed:

```
1. DY1
2. DY3
3. DY5
4. DY7
5. DY9
6. DY11
```

Select the transformer configuration by pressing the corresponding key (**[1]** to **[6]**). For this example, press the **[1]** key (*Dy1*).

e. The following screen will be displayed:

```
NAME PLATE VOLTAGE?
1. YES
2. NO
3. USE PREV DATA
```

NOTE

Option 3 (*USE PREV DATA*) will be listed only if you had provided name plate voltages for a previous test.

1. *YES*

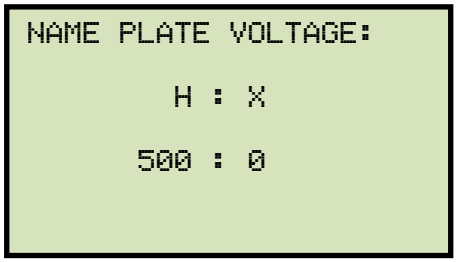
Press the **[1]** key (*YES*) if you would like to enter the transformer name plate voltage values. The following screen will be displayed:

```
NAME PLATE VOLTAGE:
        H : X
        0 :
```

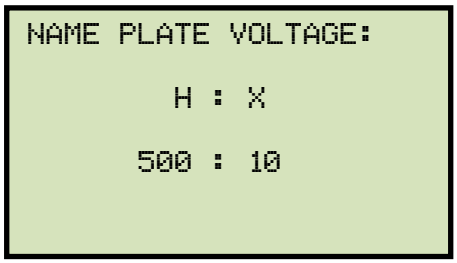
Type the H winding name plate voltage value using the numeric keypad. The screen will be updated as shown:

```
NAME PLATE VOLTAGE:
        H : X
      500 :
```

Press the **[ENTER]** key. The following screen will be displayed:



Type the X winding name plate voltage value using the numeric keypad. The screen will be updated as shown:



Press the **[ENTER]** key. **Continue to step f**.

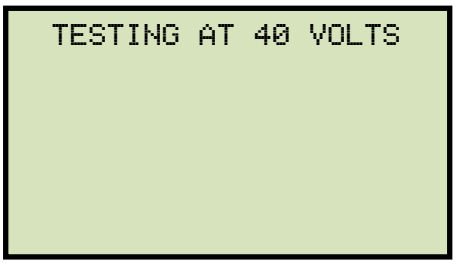
2. *NO*

   Press the **[2]** key (*NO*) if you do not want to enter the transformer name plate voltage. **Continue to step f.**

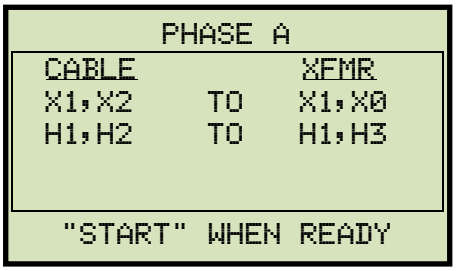
3. *USE PREV DATA*

   Press the **[3]** key (*USE PREV DATA*) to use the name plate voltage values entered when performing the last test. **Continue to step f.**

f. The following screen will be displayed momentarily:

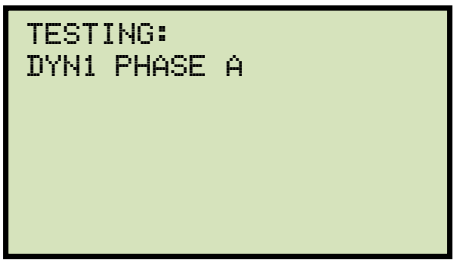


Then the following screen will be displayed showing the Phase A cable connections for the selected test (this will differ depending on the test selected):

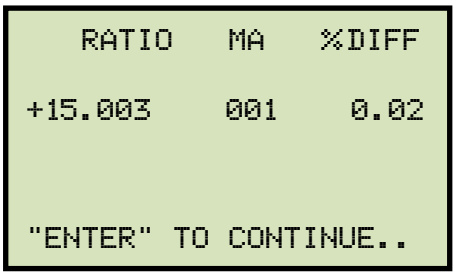


Make the cable connections per the instructions and then press the **[START]** key to run the Phase A test.

g. The following screen will be displayed while the test is being performed:

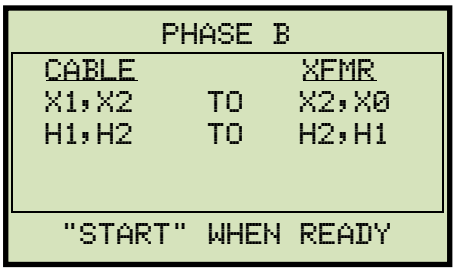


The Phase A test results will be displayed on the LCD screen when testing has finished:



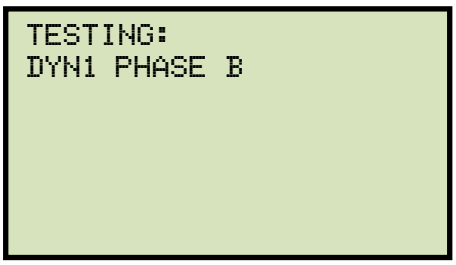
Press the **[ENTER]** key to continue.

h. The following screen will be displayed showing the Phase B cable connections for the selected test:



Make the cable connections per the instructions and then press the **[START]** key to run the Phase B test.

i. The following screen will be displayed while the test is being performed:



The Phase A and B test results will be displayed on the LCD screen when testing has finished:

```
   RATIO    MA    %DIFF

+15.003     001     0.02
+15.015     001     0.10


"ENTER" TO CONTINUE..
```

Line 1 of the results shows the Phase A test results, and line 2 shows the Phase B test results.

Press the **[ENTER]** key to continue.

j. The following screen will be displayed showing the Phase C cable connections for the selected test:

```
        PHASE C
 CABLE          XFMR
 X1,X2    TO    X3,X0
 H1,H2    TO    H3,H2


  "START" WHEN READY
```

Make the cable connections per the instructions and then press the **[START]** key to run the Phase C test.

k. The following screen will be displayed while the test is being performed:

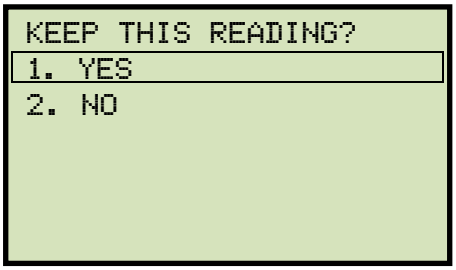
```
TESTING:
DYN1 PHASE C
```

The Phase A, B, and C test results will be displayed on the LCD screen when testing has finished:

```
     TEST RESULTS:
   RATIO    MA    %DIFF
A +15.003    001    0.02
B +15.015    001    0.10
C +15.000    001    0.00
181.4°   183.2°   181.8°
 XFMR TYPE: DYN1
```

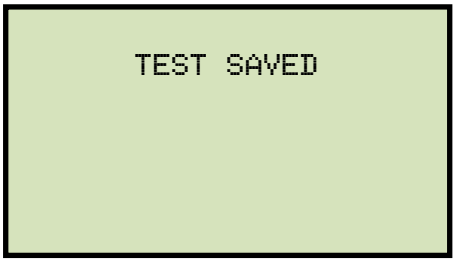
The phase angles for Phase A, B, and C are also displayed at the bottom of the test results from left to right, respectively. Press any key to continue.

l. The following screen will be displayed:



Press the **[1]** key (*YES*) to save the reading.

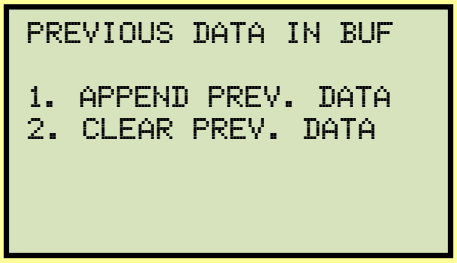
m. The following screen will be displayed:



Press any key to continue.

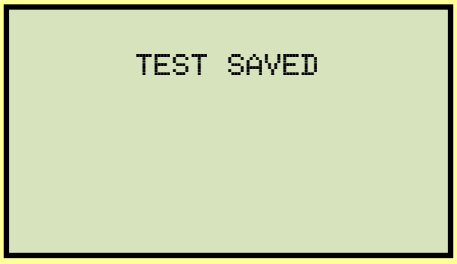
NOTE

The above screen will be displayed if there is currently no data in the unit's memory buffer. If a test was previously performed or a test record was restored from Flash EEPROM or from a Flash drive, the following screen will be displayed instead:



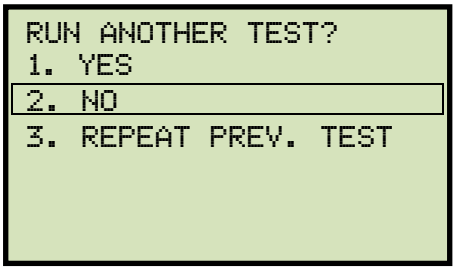
Press the **[1]** key (*APPEND PREV. DATA*) to append the data in the unit's working memory to the current test results, or press the **[2]** key (*CLEAR PREV. DATA*) to clear any previous data from the unit's memory buffer and only save the current test results.

The following screen will then be displayed:



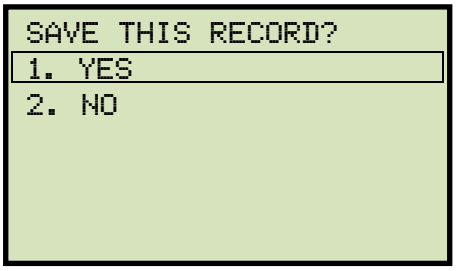
Press any key to continue.

n. The following screen will be displayed:



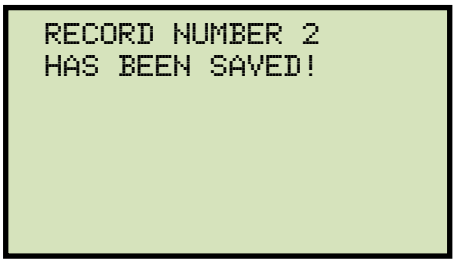
Press the **[2]** key (*NO*).

o. The following screen will be displayed:



Press the **[1]** key (*YES*) to save the test record to the unit's Flash EEPROM.

p. The test record will be saved and the following screen will be displayed:



NOTE The unit will automatically assign the record number and will not over-write existing test records.

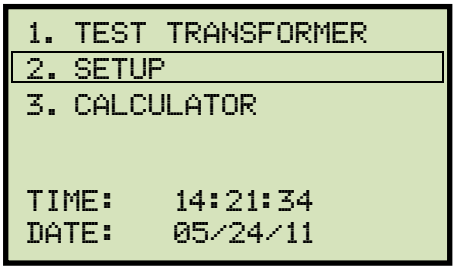
Press any key to return to the "START-UP" menu.

3.7 Working With Test Records

3.7.1. Viewing the Contents of the Working Memory

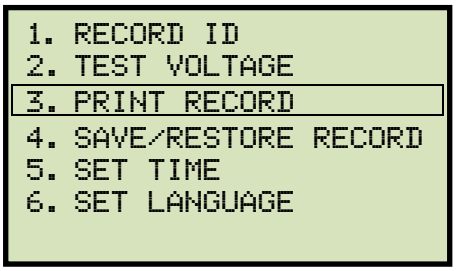
Whenever a test is performed or a test record is retrieved, the data is stored in the ATRT's working memory. You can view the test data using the steps below:

a. Start from the "START-UP" menu:



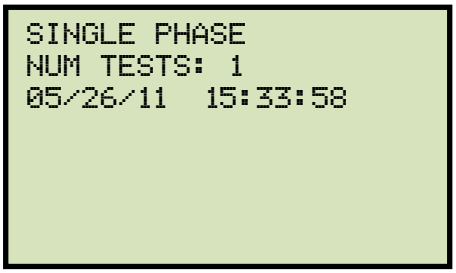
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

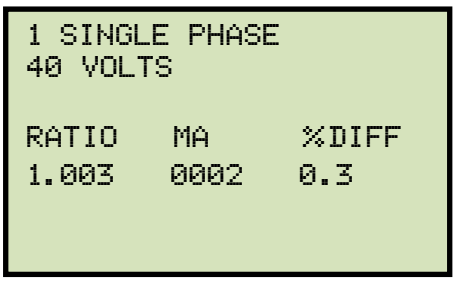


Press the **[3]** key (*PRINT RECORD*).

c. The basic test record information will be displayed as shown:



Press the **[Contrast ∨]** key. The test record details will be displayed as shown below:

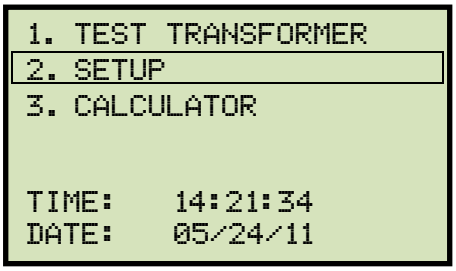


Press the **[STOP]** key to return to the "START-UP" menu.

3.7.2. Saving Test Results to a Test Record

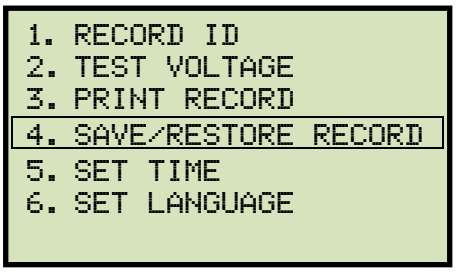
After performing a test, the user is presented the option to save the test results to the unit's Flash EEPROM or to a USB Flash Drive. If the test results are not saved immediately after performing a test, they will still remain in the working memory and can be saved later, as long as a new test has not been performed and the unit has not been turned off. Follow the steps below to save the test results from the working memory to a test record (the following procedure can also be used to re-save a restored test record to a new memory location or to a USB Flash Drive):

a. Perform a test or restore a test record to the working memory (see section 3.7.3 and 3.7.4), and then start from the "START-UP" menu:



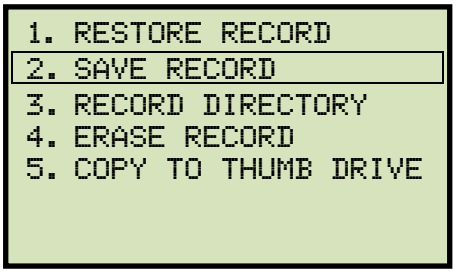
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*SAVE/RESTORE RECORD*)

c. The following screen will be displayed:



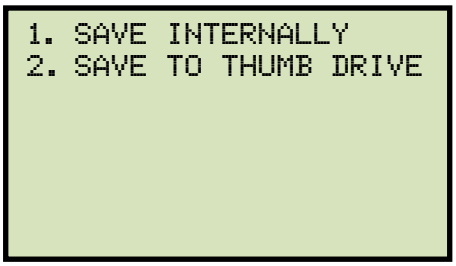
NOTE Option 5 (*COPY TO THUMB DRIVE*) will be listed only if a USB Flash drive is connected to the ATRT.

Press the **[2]** key (*SAVE RECORD*).

If a USB Flash drive is connected to the unit, continue to step d.

If a USB Flash drive is NOT connected to the unit, continue to step e.

d. The following screen will be displayed:

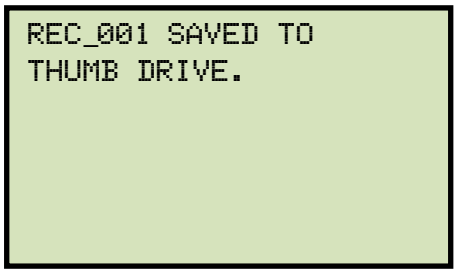


1. *SAVE INTERNALLY*

   Press the **[1]** key (*SAVE INTERNALLY*) to save the test record to the unit's Flash EEPROM. **Continue to step e.**

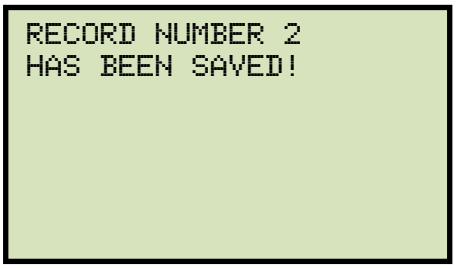
2. *SAVE TO THUMB DRIVE*

   Press the **[2]** key (*SAVE TO THUMB DRIVE*) to save the test record to the connected USB Flash drive. The following screen will be displayed:



   Press any key to return to the "START-UP" menu.

e. The following screen will be displayed:

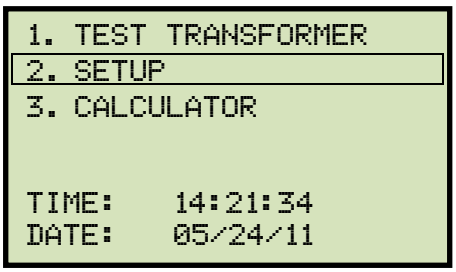


Press any key to return to the "START-UP" menu.

3.7.3. Restoring a Test Record From Flash EEPROM

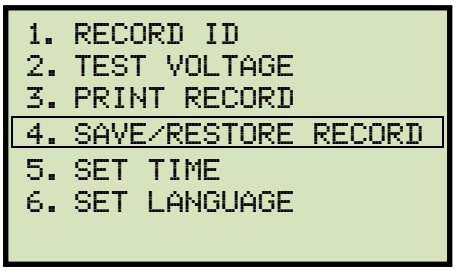
Use the steps below to restore a test record from the ATRT's Flash EEPROM to the working memory:

a. Start from the "START-UP" menu:



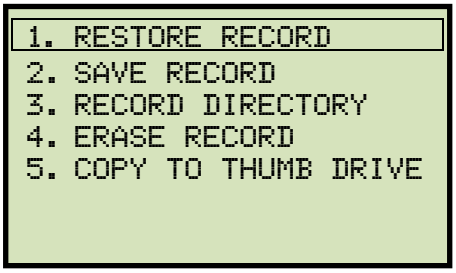
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*SAVE/RESTORE RECORD*).

c. The following screen will be displayed:



NOTE Option 5 (*COPY TO THUMB DRIVE*) will be listed only if a USB Flash drive is connected to the ATRT.

Press the **[1]** key (*RESTORE RECORD*).

d. The following screen will be displayed:

```
    RESTORE RECORD
1.ENTER RECORD NUMBER
2.SCROLL TO SELECT
```

NOTE

If you have a USB Flash drive inserted in the ATRT's "USB MEM" port, the following screen will be displayed instead of the above screen:

```
1.INTERNAL STORAGE
2.THUMB DRIVE
```

Press the **[1]** key (*INTERNAL STORAGE*).

The following screen will be displayed:

```
    RESTORE RECORD
1.ENTER RECORD NUMBER
2.SCROLL TO SELECT
```

Continue with the steps below.

1. ENTER RECORD NUMBER

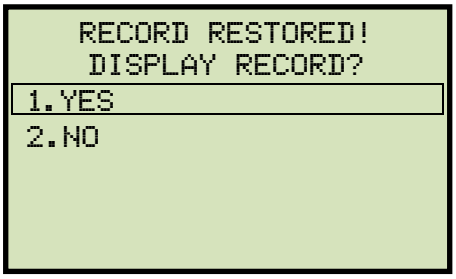
Press the **[1]** key (*ENTER RECORD NUMBER*) if you know the record number that you would like to restore.

1.1. The following screen will be displayed:

```
  RESTORE RECORD
    NUMBER:
```

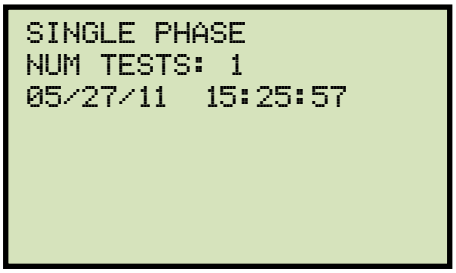
Type the record number using the alpha-numeric keypad and then press the **[ENTER]** key.

1.2. The following screen will be displayed:

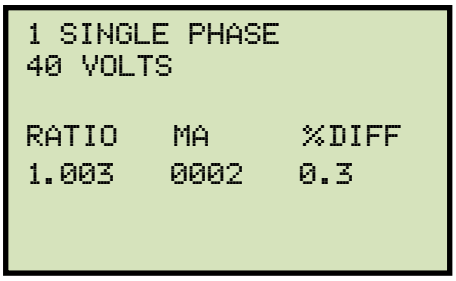


Press the **[1]** key (*YES*) to display the test record.

1.3. The basic information about the restored test record will be displayed as shown:



Press the **[Contrast ∨]** key. The test record details will be displayed as shown:

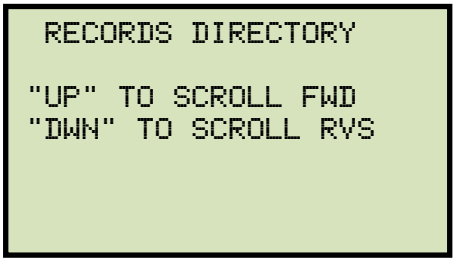


Press the **[STOP]** key to return to the "START-UP" menu. The restored test record will remain loaded in the working memory.

2. *SCROLL TO SELECT*

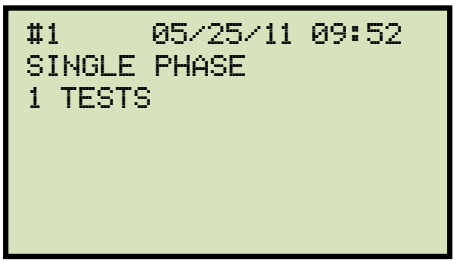
Press the **[2]** key (*SCROLL TO SELECT*) to scroll through a directory of the stored test records.

2.1. The following screen will be displayed:



Press the **[Contrast ∧]** button or the **[Contrast ∨]** key to display the next or previous test record, respectively.

The basic test record information will be displayed as shown:

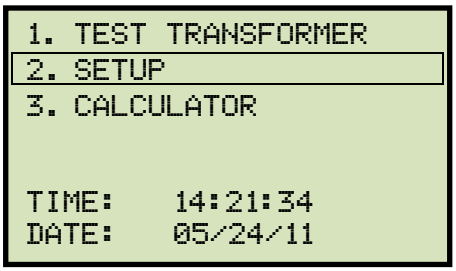


When you have located the test record that you would like to restored, press the **[ENTER]** key. **Continue to step 1.2 on page 40.**

3.7.4. Restoring a Test Record From a USB Flash Drive

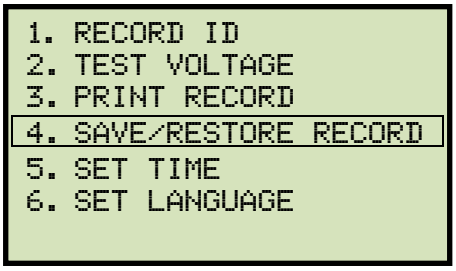
Use the steps below to restore a test record from a USB Flash drive to the ATRT's working memory:

a. Make sure the USB Flash drive containing the test record(s) is inserted in the ATRT's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



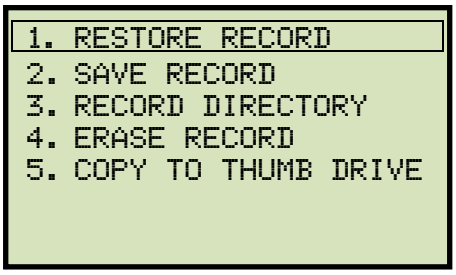
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



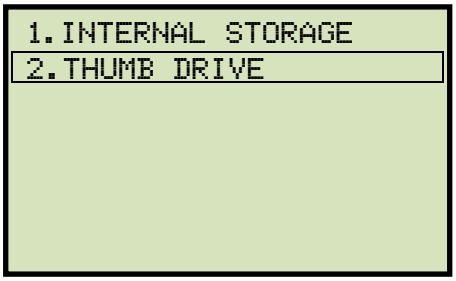
Press the **[4]** key (*SAVE/RESTORE RECORD*)

c. The following screen will be displayed:



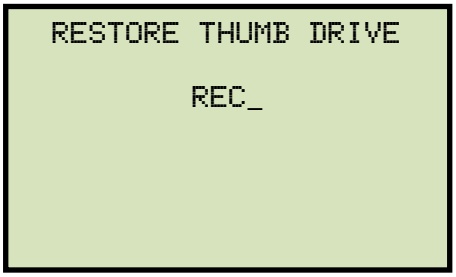
Press the **[1]** key (*RESTORE RECORD*).

d. The following screen will be displayed:



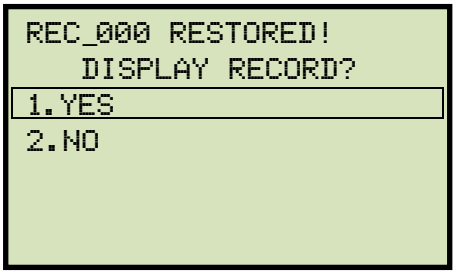
Press the **[2]** key (*THUMB DRIVE*).

e. The following screen will be displayed:



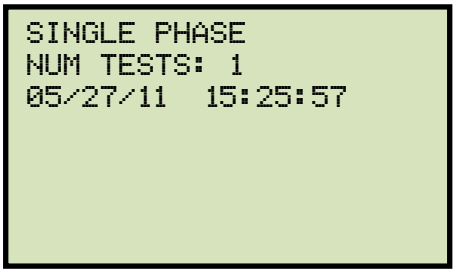
Type the record number that you would like to restore using the alpha-numeric keypad and then press the **[ENTER]** key.

f. The test record will be restored to the unit's working memory and the following screen will be displayed:

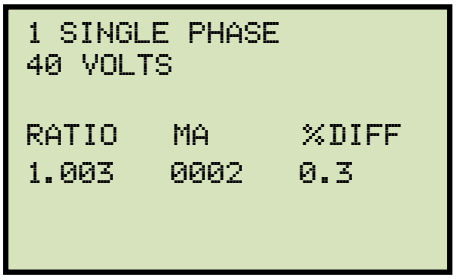


Press the **[1]** key (*YES*) to display the restored test record.

g. The basic information about the restored test record will be displayed as shown below:



Press the **[Contrast ⌄]** key. The test record details will be displayed as shown below:

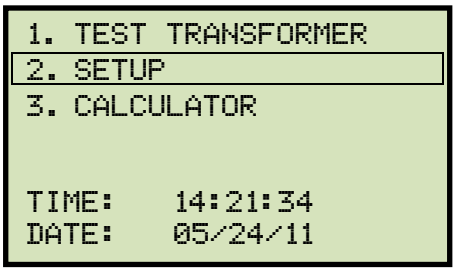


Press the **[STOP]** key to return to the "START-UP" menu. The restored test record will remain loaded in the working memory.

3.7.5. Copying Test Records to a USB Flash Drive

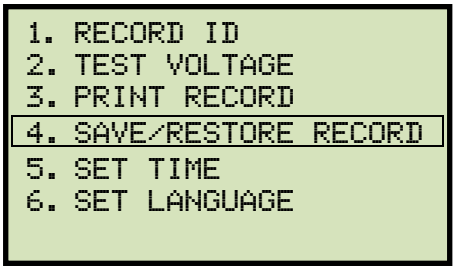
Use the steps below to copy one or all test records from the unit's Flash EEPROM to a connected USB Flash drive:

a. Make sure a USB Flash drive is connected to the unit's "USB MEM" port, and then start from the "START-UP" menu:



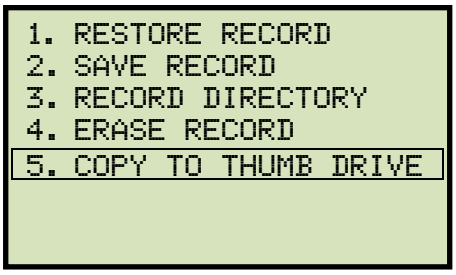
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*SAVE/RESTORE RECORD*).

c. The following screen will be displayed:



Press the **[5]** key (*COPY TO THUMB DRIVE*).

d. The following screen will be displayed:

```
COPY REC TO THUMB DRV

1.COPY SINGLE RECORD
2.COPY ALL RECORDS
```

1. *COPY SINGLE RECORD*

Press the **[1]** key (*COPY SINGLE RECORD*) to copy a single test record from the ATRT's Flash EEPROM to the connected USB Flash drive. The following screen will be displayed:

```
ENTER RECORD NUMBER
TO COPY TO FLASH DRV

    NUMBER:
```

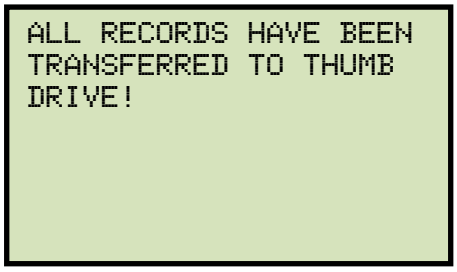
Type the record number using the alpha-numeric keypad and then press the **[ENTER]** key. The test record will be copied to the USB Flash drive and the following screen will be displayed:

```
REC_000 SAVED TO
THUMB DRIVE
```

Press any key to return to the "START-UP" menu.

2. *COPY ALL RECORDS*

Press the **[2]** key (*COPY ALL RECORDS*) to copy all test records from the ATRT's Flash EEPROM to the connected USB Flash drive. All test records will be copied from the unit to the connected USB Flash drive. The following screen will be displayed when the process is finished:

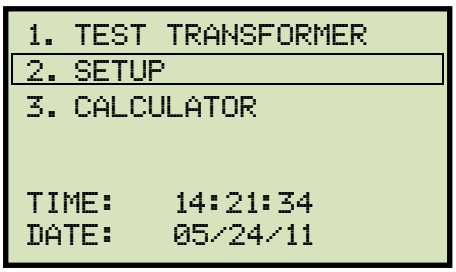


Press any key to return to the "START-UP" menu.

3.7.6. Viewing the Test Record Directory

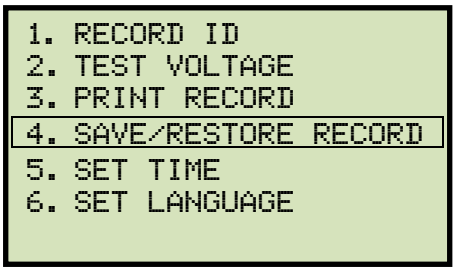
Use the steps below to browse through a directory of the test records stored in the ATRT's Flash EEPROM memory:

a. Start from the "START-UP" menu:



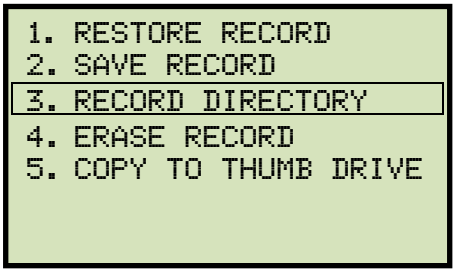
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*SAVE/RESTORE RECORD*).

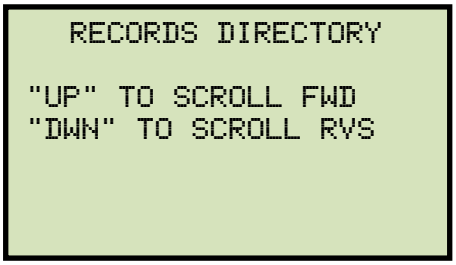
c. The following screen will be displayed:



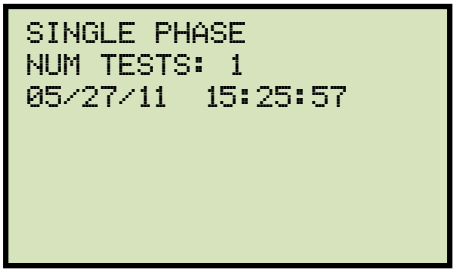
NOTE Option 5 (*COPY TO THUMB DRIVE*) is listed only if a USB Flash drive is connected to the unit.

Press the **[3]** key (*RECORD DIRECTORY*).

d. The following screen will be displayed:



Press the **[Contrast ∧]** or **[Contrast ∨]** key to scroll through the test record directory. The test record header will be displayed as shown:

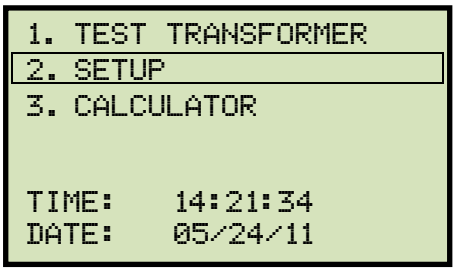


You can continue to scroll through the record directory by pressing the **[Contrast ∧]** and **[Contrast ∨]** keys. Press the **[STOP]** key to return to the "START-UP" menu.

3.7.7. Erasing Test Records from the Flash EEPROM

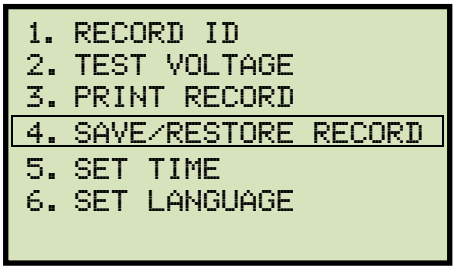
Follow the steps below to erase test records from the Flash EEPROM

a. Start from the "START-UP" menu:



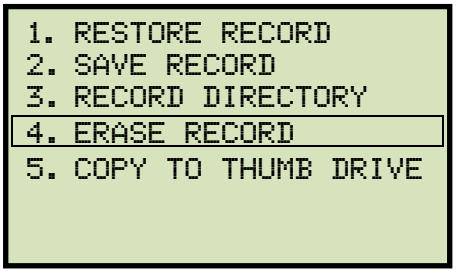
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*SAVE/RESTORE RECORD*).

c. The following screen will be displayed:



Press the **[4]** key (*ERASE RECORD*).

d. The following screen will be displayed:

```
      ERASE RECORD

1.ERASE SINGLE REC.
2.ERASE ALL RECORDS

    "STOP" TO EXIT
```

NOTE

If you have a USB Flash drive inserted in the ATRT's "USB MEM" port, the following screen will be displayed instead of the above screen:

```
1.ERASE INTERNAL REC
2.ERASE THUMB DRV REC
```

Press the **[1]** key (*ERASE INTERNAL REC*).

The following screen will be displayed:

```
      ERASE RECORD

1.ERASE SINGLE REC.
2.ERASE ALL RECORDS

    "STOP" TO EXIT
```

Continue with the steps below.

1. ERASE SINGLE REC.

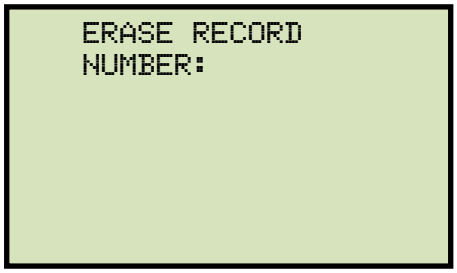
Press the **[1]** key (*ERASE SINGLE REC.*) to erase a single test record from the unit's internal Flash EEPROM. The following screen will be displayed:

```
      ERASE RECORD

1.ENTER RECORD NUMBER
2.SCROLL TO SELECT
```

1. ENTER RECORD NUMBER

Press the **[1]** key (*ENTER RECORD NUMBER*) if you know the record number that you would like to erase. The following screen will be displayed:



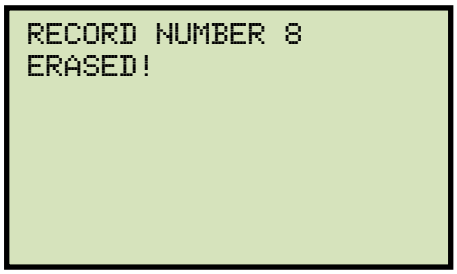
NOTE

You can cancel the process and return to the "START-UP" menu by pressing the **[STOP]** key.

Type the record number that you would like to erase using the alpha-numeric keypad and then press the **[ENTER]** key. If you do not know the test record number, you can first view the test record directory using the instructions in section 3.7.6.

The following screen will be displayed while the record is being erased:

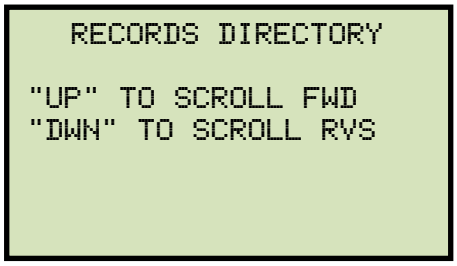
The following screen will be displayed when the test record has been completely erased:



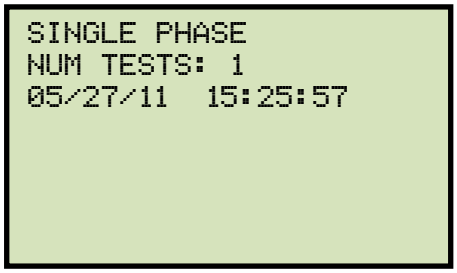
Press any key to continue. You will be returned to the beginning of step d.

2. *SCROLL TO SELECT*

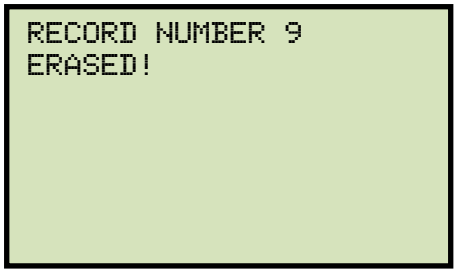
Press the **[2]** key (*SCROLL TO SELECT*) to scroll through the test record directory and locate the test record that you would like to erase. The following screen will be displayed:



Press the **[Contrast ∧]** or **[Contrast ∨]** key to scroll through the test record directory. The test record header will be displayed as shown:



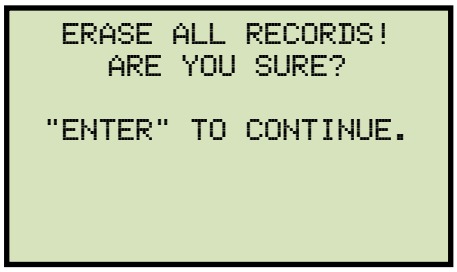
You can continue to scroll through the record directory by pressing the **[Contrast ∧]** and **[Contrast ∨]** keys. Once you have located the test record you would like to erase, press the **[ENTER]** key. The selected test record will be erased and the following screen will be displayed:



Press any key to continue. You will be returned to the beginning of step d.

2. *ERASE ALL RECORDS*

Press the **[2]** key (*ERASE ALL RECORDS*) to erase all the test records from the unit's internal Flash EEPROM. The following warning screen will be displayed:



You can press the **[STOP]** key to cancel the process and return to the "START-UP" menu.

Press the **[ENTER]** key to proceed with deleting all the test records from the unit's Flash EEPROM. The following screen will be displayed during the erasure process:

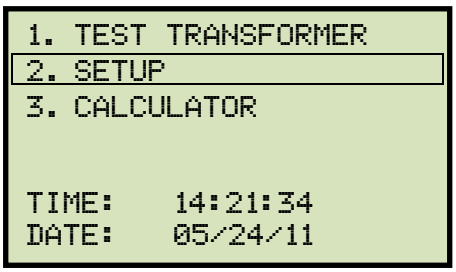
The following screen will be displayed when all test records have been completely erased:

Press any key to return to the "START-UP" menu.

3.7.8. Erasing Test Records from a USB Flash Drive

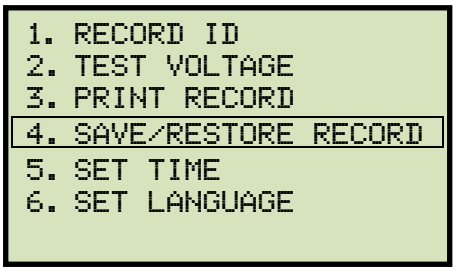
Follow the steps below to erase test records from a USB Flash drive:

a. Make sure a USB Flash drive is connected to the unit's "USB MEM" port, and then start from the "START-UP" menu:



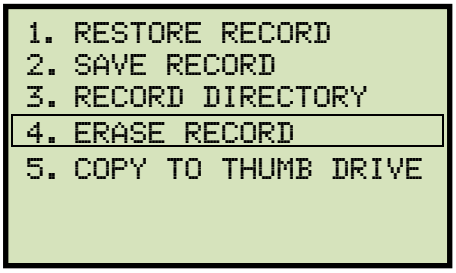
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



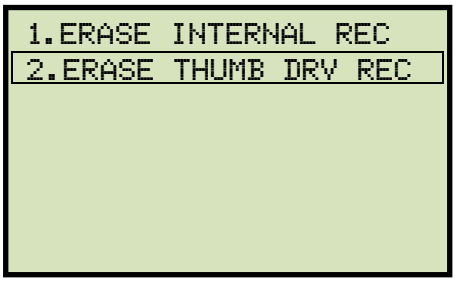
Press the **[4]** key (*SAVE/RESTORE RECORD*).

c. The following screen will be displayed:



Press the **[4]** key (*ERASE RECORD*).

d. The following screen will be displayed:



Press the **[2]** key (*ERASE THUMB DRV REC*).

e. The following screen will be displayed:

```
     ERASE RECORD

1.ERASE SINGLE REC.
2.ERASE ALL RECORDS

    "STOP" TO EXIT
```

1. *ERASE SINGLE REC.*

   Press the **[1]** key (*ERASE SINGLE REC.*) to erase a single test record from the connected USB Flash drive. The following screen will be displayed:

```
  ERASE THUMB DRIVE

   REC_
```

   Type the record number that you would like to erase using the alpha-numeric keypad and then press the **[ENTER]** key. The test record will be erased from the USB Flash drive and the following screen will be displayed:

```
THUMB DRIVE RE000
ERASED!
```

   Press any key to continue. You will be returned to the beginning of step e. Press the **[STOP]** key to return to the "START-UP" menu.

2. *ERASE ALL RECORDS*

   Press the **[2]** key (*ERASE ALL RECORDS*) to delete all test records from the connected USB Flash drive. The following warning screen will be displayed:

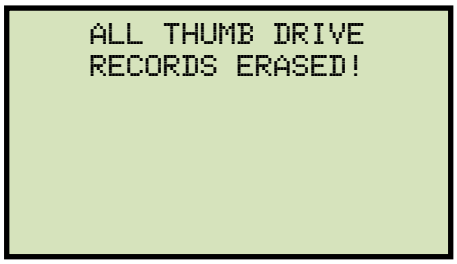
```
ERASE ALL THUMB DRIVE
RECORDS!

      ARE YOU SURE?

 "ENTER" TO CONTINUE.
```

Press the **[STOP]** key if you do not want to erase all the test records. You will be returned to the "START-UP" menu.

Press the **[ENTER]** key to proceed with deleting all the test records from the connected USB Flash drive. The following screen will be displayed when all the records have been erased:

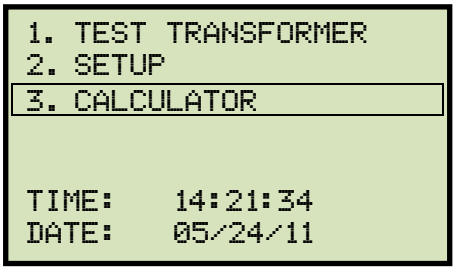


Press any key to return to the "START-UP" menu.

3.8 Using the Turns Ratio Calculator

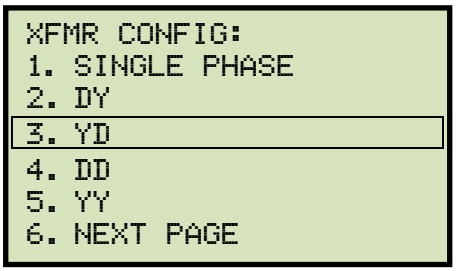
The ATRT-01 and ATRT-01B S2 feature a turns ratio calculator that can be used to calculate the turns ratio for various transformer types. The user only needs to provide the H and X name plate voltage values and the unit will calculate the turns ratio. Follow the steps below to use the turns ratio calculator.

a. Start from the "START-UP" menu:



Press the **[3]** key (*CALCULATOR*).

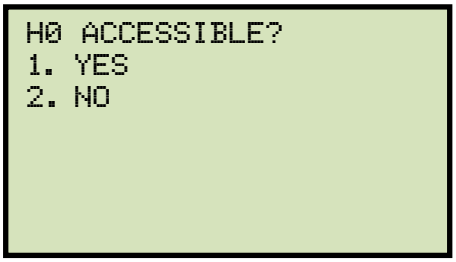
b. The following screen will be displayed:



Select the transformer configuration by pressing the corresponding key on the keypad. You can press the **[6]** key (*NEXT PAGE*) to view additional transformer configuration types. For this example, press the **[3]** key (*Yd*) to select the Y-dT transformer type.

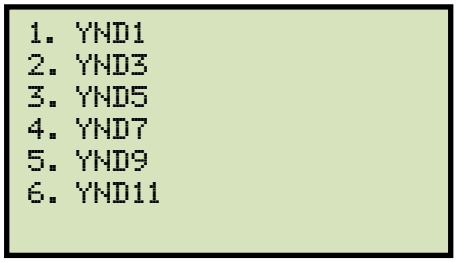
NOTE The following steps will differ for other transformer configuration types.

c. The following screen will be displayed:



1. *YES*

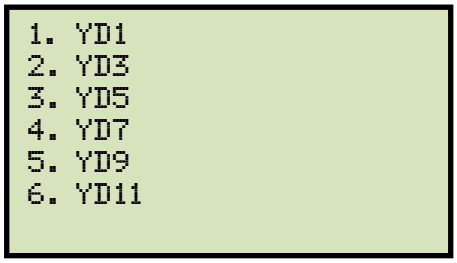
   Press the **[1]** key (*YES*) if H0 is accessible. The following screen will be displayed:



   Select the transformer configuration by pressing the corresponding key.
   Continue to step d.

2. *NO*

   Press the **[2]** key (*NO*) if H0 is not accessible. The following screen will be displayed:



   Select the transformer configuration by pressing the corresponding key.
   Continue to step d.

d. The following screen will be displayed

```
NAME PLATE VOLTAGE:
        H : X
        0 :
```

Type the H name plate voltage value using the keypad. The screen will be updated:

```
NAME PLATE VOLTAGE:
        H : X
    1,734 :
```

Press the **[ENTER]** key. The following screen will be displayed:

```
NAME PLATE VOLTAGE:
        H : X
    1,734 : 0
```

Type the X name plate voltage using the keypad. The screen will be updated:

```
NAME PLATE VOLTAGE:
        H : X
    1,734 : 100
```

Press the **[ENTER]** key. The ratio will be calculated and displayed at the bottom of the screen:

```
NAME PLATE VOLTAGE:
        H : X
    1,734 : 100
   RATIO = 15.017
```

Press any key to return to the "START-UP" menu.

APPENDIX A – TRANSFORMER VECTOR GROUP CODES

Utility power transformers manufactured in accordance with IEC specifications have a Rating Plate attached in a visible location. This plate contains a list of the transformer's configuration and operating specifications. One such rating is the winding configuration and phase-displacement code. This code follows a convention that comprises letter and number sets that denote three-phase winding configurations (i.e., Wye, delta, or zig-zag). Letter symbols for the different windings are noted in descending order of their rated voltages. That is, symbols denoting higher voltage ratings will be in upper-case letters and symbols denoting lower or intermediate voltage ratings will be in lower-case letters. If the neutral point of either a wye or zig-zag winding is brought out, the indication will be an N (high voltage) or n (lower voltage). The end numeral is a 300 multiplier that indicates phase lag between windings.

Accordingly, the following standard practice applies:

Wye (or star) = Y (high voltage) or y (low voltage)

Delta = D (high voltage) or d (low voltage)

Zig-zag = Z (high voltage) or z (low voltage)

For example, **Dyn11** decodes as follows:

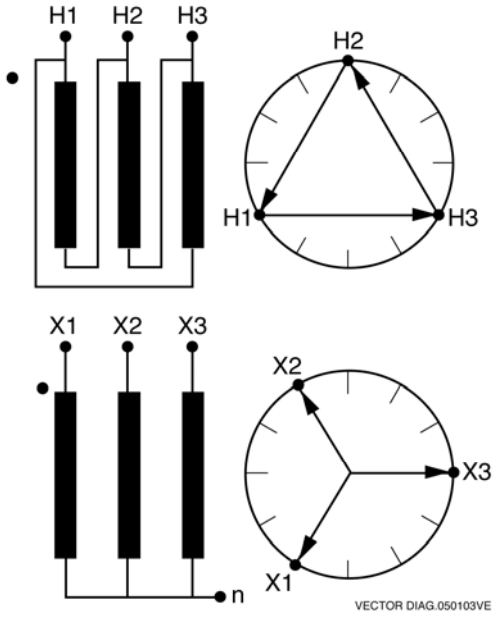
D indicates that the high-voltage windings are connected in a Delta configuration

(Since delta windings do not have a neutral point, the N never appears after a D).

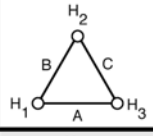
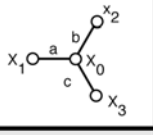
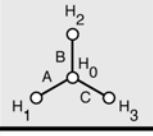
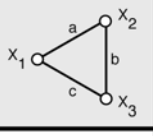
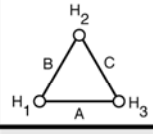
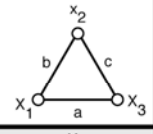
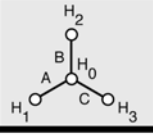
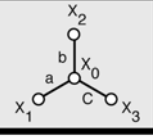
y indicates that the lower voltage winding is in a wye (or star) configuration.

n indicates that the lower voltage windings have the neutral point brought out.

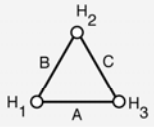
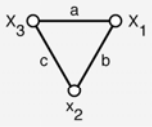
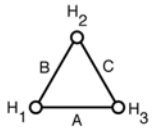
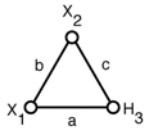
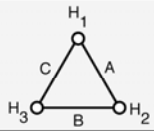
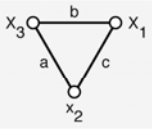
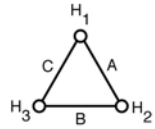
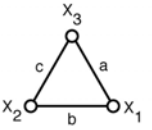
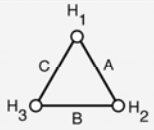
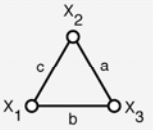
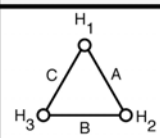
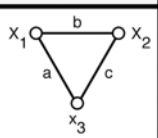
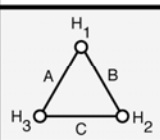
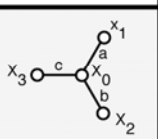
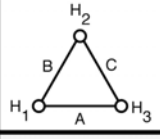
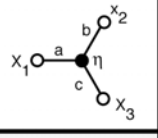
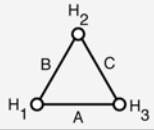
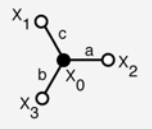
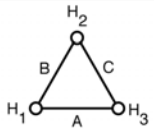
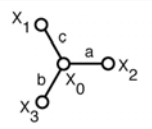
11 indicates a phase-displacement lag of 330 degrees between the Wye and the Delta winding.



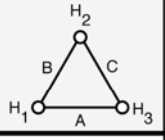
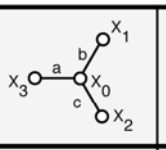
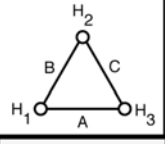
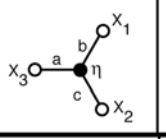
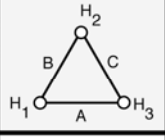
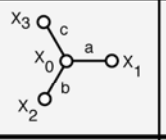
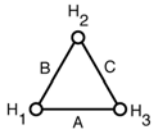
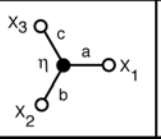
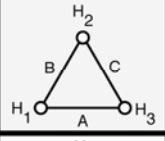
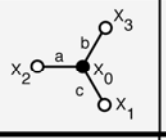
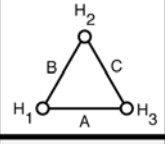
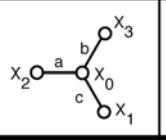
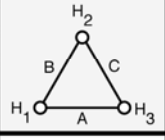
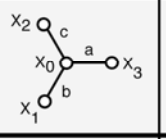
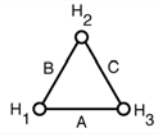
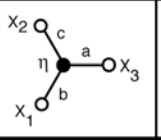
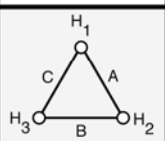
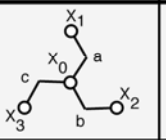
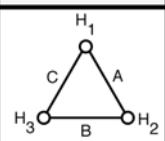
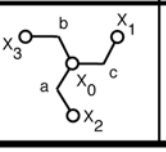
APPENDIX B – Common ANSI Transformer Descriptions

STD TEST NO.	TRANSFORMER CONFIGURATION		PHASE	WINDING TESTED		TURNS RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
1			1 Ø	$H_1 - H_2$	$X_1 - X_2$	$\frac{V_H}{V_x}$	1ph0	SNG – PHS
2			A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_0$ $X_2 - X_0$ $X_3 - X_0$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dyn1	d t – Y
3			A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_1 - X_2$ $X_2 - X_3$ $X_3 - X_1$	$\frac{V_H}{V_x \cdot \sqrt{3}}$	YNd1	y – d t
4			A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_x}$	Dd0	d t – d t
5			A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_1 - X_0$ $X_2 - X_0$ $X_3 - X_0$	$\frac{V_H}{V_x}$	YNyn0	y – y

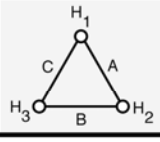
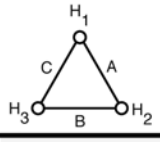
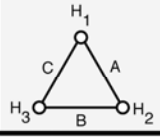
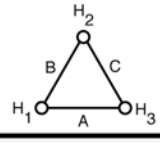
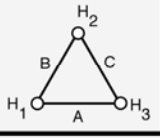
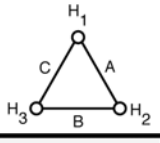
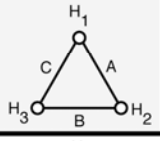
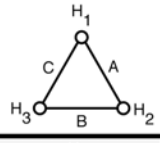
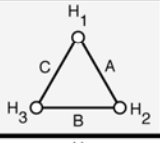
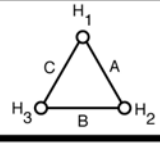
VANGUARD.050207V1

SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
1			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_x}$	Dd6	
37			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_x}$	Dd0	
38			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_3 - X_2$ $X_1 - X_3$ $X_2 - X_1$	$\frac{V_H}{V_x}$	Dd2	
39			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_x}$	Dd4	
40			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_2 - X_3$ $X_3 - X_1$ $X_1 - X_2$	$\frac{V_H}{V_x}$	Dd8	
41			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_x}$	Dd10	
42			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_0$ $X_2 - X_0$ $X_3 - X_0$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dyn1	
2			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dy1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
61			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_2$ $X_2 - X_3$ $X_3 - X_1$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dy3	NO ACCESSIBLE NEUTRAL ON WYE WINDING
62			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_0 - X_2$ $X_0 - X_3$ $X_0 - X_1$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dyn3	

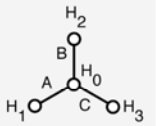
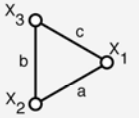
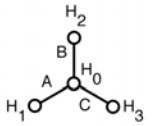
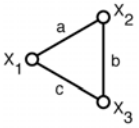
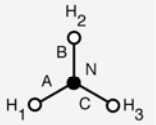
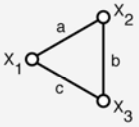
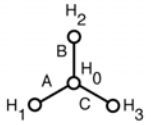
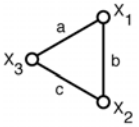
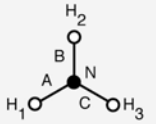
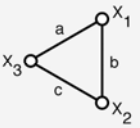
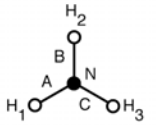
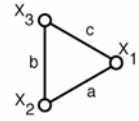
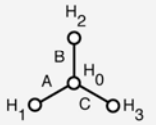
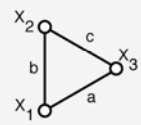
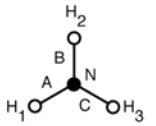
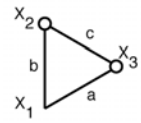
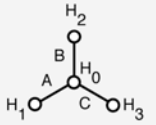
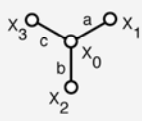
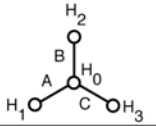
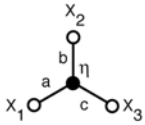
VANGUARD.050108V1

SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
3			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_3 - X_0$ $X_1 - X_0$ $X_2 - X_0$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn5	
4			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_3 - X_2$ $X_1 - X_3$ $X_2 - X_1$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
5			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_0 - X_1$ $X_0 - X_2$ $X_0 - X_3$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn7	
6			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
63			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_2 - X_1$ $X_3 - X_2$ $X_1 - X_3$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy9	NO ACCESSIBLE NEUTRAL ON WYE WINDING
64			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_2 - X_0$ $X_3 - X_0$ $X_1 - X_0$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn9	
7			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_0 - X_3$ $X_0 - X_1$ $X_0 - X_2$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn11	
8			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_2 - X_3$ $X_3 - X_1$ $X_1 - X_2$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
45			$H_2 - H_3$ $H_3 - H_1$ $H_1 - H_2$	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_1 - X_0$ $X_2 - X_0$ $X_3 - X_0$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn0	
46			$H_2 - H_3$ $H_3 - H_1$ $H_1 - H_2$	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_0 - X_2$ $X_0 - X_3$ $X_0 - X_1$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn2	

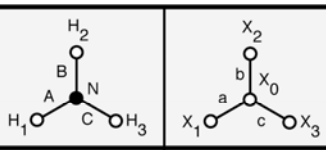
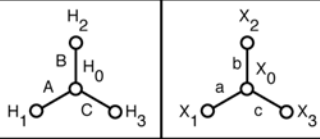
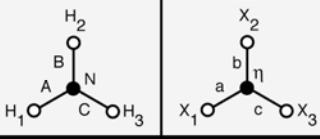
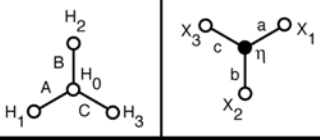
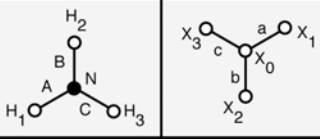
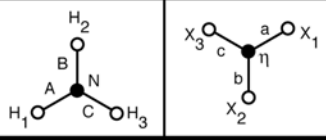
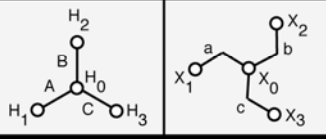
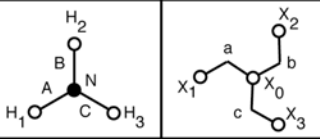
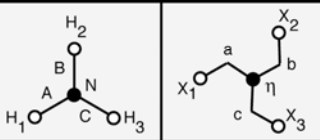
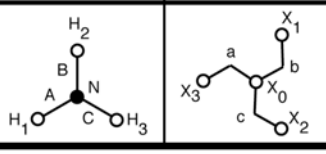
VANGUARD.050108V2

SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
47			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_3 - X_2$ $X_1 - X_3$ $X_2 - X_1$	$\frac{V_H}{V_x}$	Dz2	NO ACCESSIBLE NEUTRAL
48			$H_2 - H_3$ $H_3 - H_1$ $H_1 - H_2$	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_3 - X_0$ $X_1 - X_0$ $X_2 - X_0$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn4	
49			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_x}$	Dz4	NO ACCESSIBLE NEUTRAL
9			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_x}$	Dz0	NO ACCESSIBLE NEUTRAL
10			—	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_x}$	Dz6	NO ACCESSIBLE NEUTRAL
50			$H_2 - H_3$ $H_3 - H_1$ $H_1 - H_2$	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_0 - X_1$ $X_0 - X_2$ $X_0 - X_3$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn6	
51			$H_2 - H_3$ $H_3 - H_1$ $H_1 - H_2$	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_2 - X_0$ $X_3 - X_0$ $X_1 - X_0$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn8	
52			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_2 - X_3$ $X_3 - X_1$ $X_1 - X_2$	$\frac{V_H}{V_x}$	Dz8	NO ACCESSIBLE NEUTRAL
53			$H_2 - H_3$ $H_3 - H_1$ $H_1 - H_2$	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_0 - X_3$ $X_0 - X_1$ $X_0 - X_2$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn10	
54			—	A B C	$H_1 - H_2$ $H_2 - H_3$ $H_3 - H_1$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_x}$	Dz10	NO ACCESSIBLE NEUTRAL

VANGUARD.050108V3

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
11			—	A	$H_1 - H_0$	$X_2 - X_1$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd7	
				B	$H_2 - H_0$	$X_3 - X_2$			
				C	$H_3 - H_0$	$X_1 - X_3$			
44			—	A	$H_1 - H_0$	$X_1 - X_2$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd1	
				B	$H_2 - H_0$	$X_2 - X_3$			
				C	$H_3 - H_0$	$X_3 - X_1$			
12			$H_3 - H_2$	A	$H_1 - H_3$	$X_1 - X_2$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_2 - X_3$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_3 - X_1$			
13			—	A	$H_1 - H_0$	$X_3 - X_2$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd5	
				B	$H_2 - H_0$	$X_1 - X_2$			
				C	$H_3 - H_0$	$X_2 - X_3$			
14			$H_3 - H_2$	A	$H_1 - H_3$	$X_3 - X_1$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_1 - X_2$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_2 - X_3$			
15			$H_3 - H_2$	A	$H_1 - H_3$	$X_2 - X_1$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_3 - X_2$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_1 - X_3$			
16			—	A	$H_1 - H_0$	$X_1 - X_3$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd11	
				B	$H_2 - H_0$	$X_2 - X_1$			
				C	$H_3 - H_0$	$X_3 - X_2$			
17			$H_3 - H_2$	A	$H_1 - H_3$	$X_1 - X_3$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_2 - X_1$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_3 - X_2$			
18			—	A	$H_1 - H_0$	$X_0 - X_1$	$\frac{V_H}{V_X}$	YNyn6	
				B	$H_2 - H_0$	$X_0 - X_2$			
				C	$H_3 - H_0$	$X_0 - X_3$			
19			$H_2 - H_0$	A	$H_1 - H_0$	$X_1 - X_2$	$\frac{V_H}{V_X}$	YNy0	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
			$H_3 - H_0$	B	$H_2 - H_0$	$X_2 - X_3$			
			$H_1 - H_0$	C	$H_3 - H_0$	$X_3 - X_1$			

VANGUARD.050108V4

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
20			X_3-X_0 X_1-X_0 X_2-X_0	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H}{V_x}$	Yyn0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
43			—	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H}{V_L}$	YNyn0	
21			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_3 X_2-X_1 X_3-X_2	$\frac{V_H}{V_x}$	Yy0	NO ACCESSIBLE NEUTRAL
22			H_2-H_0 H_3-H_0 H_1-H_0	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_2-X_1 X_3-X_2 X_1-X_3	$\frac{V_H}{V_x}$	YNy6	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
23			X_3-X_0 X_1-X_0 X_2-X_0	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_1 X_0-X_2 X_0-X_3	$\frac{V_H}{V_x}$	Yyn6	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
24			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_3-X_1 X_1-X_2 X_2-X_3	$\frac{V_H}{V_x}$	Yy6	NO ACCESSIBLE NEUTRAL
65			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H \bullet \sqrt{3}}{V_x}$	YNzn1	
25			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Yzn1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
26			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_2 X_2-X_3 X_3-X_1	$\frac{V_H}{V_x} \bullet \frac{\sqrt{3}}{2}$	Yz1	NO ACCESSIBLE NEUTRAL
27			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_3-X_0 X_1-X_0 X_2-X_0	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Yzn5	NO ACCESSIBLE NEUTRAL ON WYE WINDING

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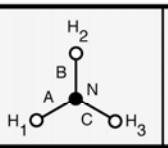
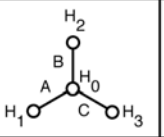
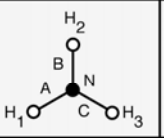
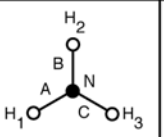
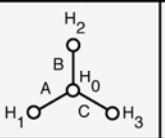
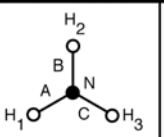
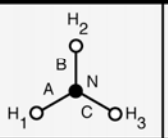
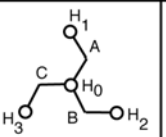
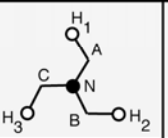
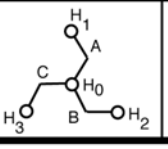
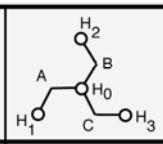
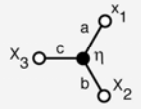
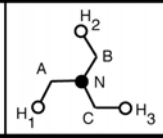
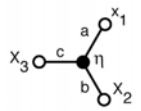
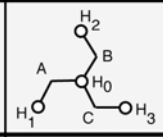
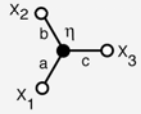
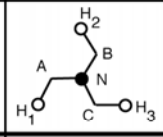
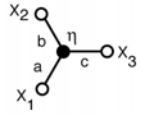
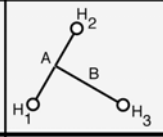
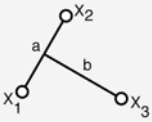
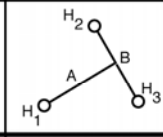
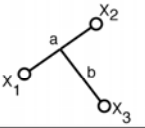
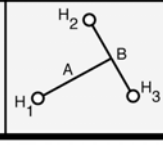
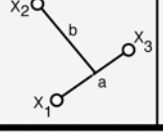
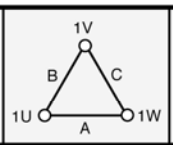
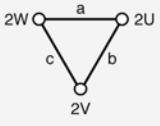
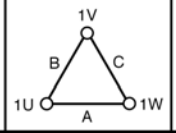
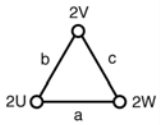
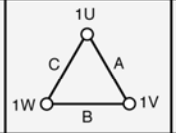
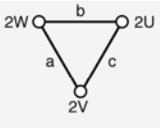
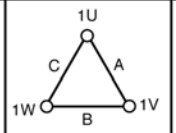
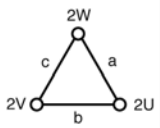
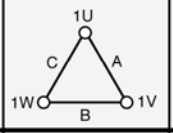
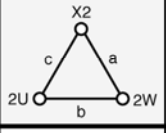
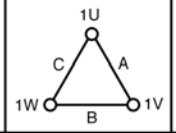
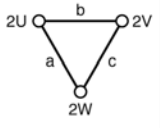
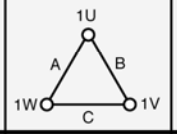
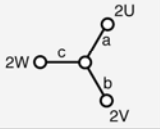
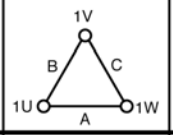
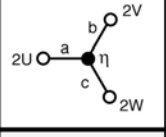
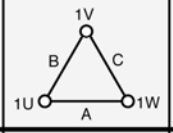
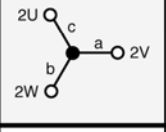
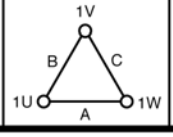
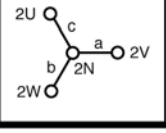
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_3-X_1 X_1-X_2 X_2-X_3	$\frac{V_H}{V_x}\bullet\frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_1 X_0-X_2 X_0-X_3	$\frac{V_H}{V_x}\bullet\frac{\sqrt{3}}{1}$	YNzn7	
29			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_1 X_0-X_2 X_0-X_3	$\frac{V_H\bullet\sqrt{3}}{V_x}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_2-X_1 X_3-X_2 X_1-X_3	$\frac{V_H}{V_x}\bullet\frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_3 X_0-X_1 X_0-X_2	$\frac{V_H\bullet\sqrt{3}}{V_x}$	YNzn11	
31			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_3 X_0-X_1 X_0-X_2	$\frac{V_H\bullet\sqrt{3}}{V_x}$	Yzn11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_3 X_2-X_1 X_3-X_2	$\frac{V_H}{V_x}\bullet\frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			X_2-X_3 X_3-X_1 X_1-X_2	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_1-X_2 X_2-X_3 X_3-X_1	$\frac{2}{3}\bullet\frac{V_H}{V_x}$	ZNd0	
56			—	A B C	H_1-H_2 H_2-H_3 H_3-H_1	X_1-X_2 X_2-X_3 X_3-X_1	$\frac{V_H}{V_x}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			X_2-X_3 X_3-X_1 X_1-X_2	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_2-X_1 X_3-X_2 X_1-X_3	$\frac{2}{3}\bullet\frac{V_H}{V_x}$	ZNd6	

VANGUARD.050108V6

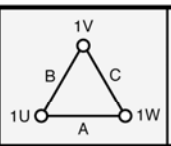
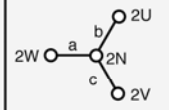
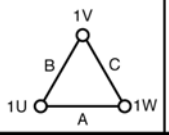
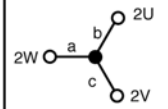
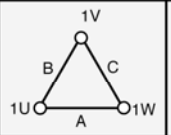
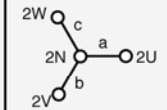
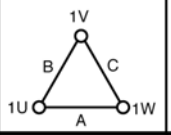
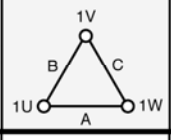
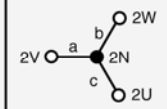
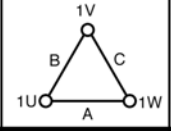
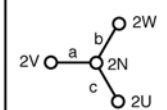
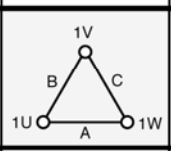
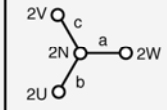
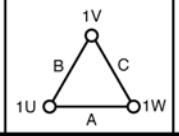
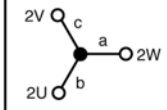
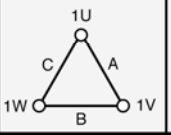
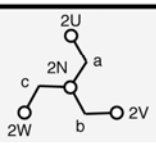
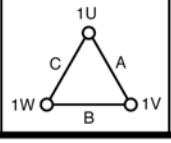
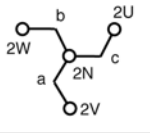
SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
33			—	A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	ZNy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
34			H_3-H_2 H_1-H_3 H_2-H_1	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Zy5	NO ACCESSIBLE NEUTRAL
35			—	A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	ZNy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
36			H_3-H_2 H_1-H_3 H_2-H_1	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Zy11	NO ACCESSIBLE NEUTRAL
58			 H_1-H_2 X_1-X_2	A B	$H_1 - H_2$ $H_1 - H_3$	$X_1 - X_2$ $X_1 - X_3$	$\frac{V_H}{V_X}$	T-T 0	
59			H_2-H_3 X_1-X_2	A B	$H_1 - H_3$ $H_2 - H_3$	$X_1 - X_2$ $X_1 - X_3$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$ $\frac{V_H}{V_X} \bullet \frac{2}{\sqrt{3}}$	T-T 30 Lag	
60			H_2-H_3 X_1-X_3	A B	$H_1 - H_3$ $H_2 - H_3$	$X_1 - X_3$ $X_2 - X_1$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$ $\frac{V_X}{V_H} \bullet \frac{2}{\sqrt{3}}$	T-T 30 Lead	

VANGUARD.050108V7

APPENDIX C – CEI/IEC 60076-1 Transformer Descriptions

SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
1			—	A B C	1U – 1W 1V – 1U 1W – 1V	2W – 2U 2U – 2V 2V – 2W	$\frac{U1}{U2}$	Dd6	
37			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2W 2V – 2U 2W – 2V	$\frac{U1}{U2}$	Dd0	
38			—	A B C	1U – 1V 1V – 1W 1W – 1U	2W – 2V 2U – 2W 2V – 2U	$\frac{U1}{U2}$	Dd2	
39			—	A B C	1U – 1W 1V – 1U 1W – 1U	2W – 2U 2U – 2V 2V – 2W	$\frac{U1}{U2}$	Dd4	
40			—	A B C	1U – 1V 1V – 1W 1W – 1U	2V – 2W 2W – 2U 2U – 2V	$\frac{U1}{U2}$	Dd8	
41			—	A B C	1U – 1V 1V – 1W 1W – 1U	2U – 2W 2V – 2U 2W – 2V	$\frac{U1}{U2}$	Dd10	
42			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2N 2V – 2N 2W – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn1	
2			1W – 1V 1U – 1W 1V – 1U	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2V 2V – 2W 2W – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
61			1W – 1V 1U – 1W 1V – 1U	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2V 2V – 2W 2W – 2U	$\frac{V_{U1} \bullet \sqrt{3}}{U2}$	Dy3	NO ACCESSIBLE NEUTRAL ON WYE WINDING
62			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2V 2N – 2W 2N – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn3	

CEI/IEC.050108C1

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
3			—	A	1U– 1W	2W – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn5	
				B	1V – 1U	2U – 2N			
				C	1W – 1V	2V – 2N			
4			1W – 1V 1U –1W 1V – 1U	A	1U– 1W	2W – 2V	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2U – 2W			
				C	1W – 1V	2V – 2U			
5			—	A	1U – 1W	2N – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn7	
				B	1V – 1U	2N –2V			
				C	1W – 1V	2N– 2W			
6			1W –1V 1U –1W 1V–1U	A	1U – 1W	2W – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
63			1W –1V 1U–1W 1V–1U	A	1U– 1W	2V – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy9	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2W – 2V			
				C	1W – 1V	2U – 2W			
64			—	A	1U– 1W	2V – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn9	
				B	1V – 1U	2W – 2N			
				C	1W – 1V	2U – 2N			
7			—	A	1U – 1W	2N – 2W	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn11	
				B	1V – 1U	2N– 2U			
				C	1W – 1V	2N – 2V			
8			1W–1V 1U –1W 1V–1U	A	1U – 1W	2V – 2W	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2W – 2U			
				C	1W – 1V	2U – 2V			
45			1V –1W 1W–1U 1U–1V	A	1U – 1V	2U – 2N	$\frac{3}{2} \bullet \frac{U1}{U2}$	Dzn0	
				B	1V – 1W	2V – 2N			
				C	1W – 1U	2W – 2N			
46			1V –1W 1W–1U 1U–1V	A	1U– 1V	2N – 2V	$\frac{3}{2} \bullet \frac{U1}{U2}$	Dzn2	
				B	1V – 1W	2N – 2W			
				C	1W – 1U	2N – 2U			

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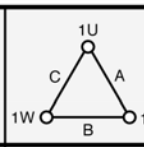
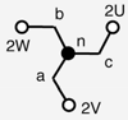
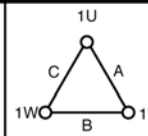
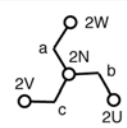
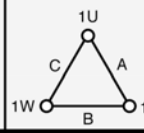
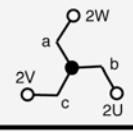
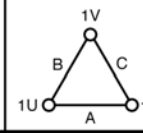
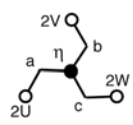
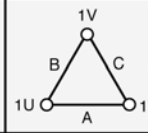
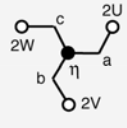
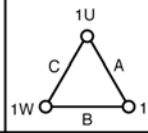
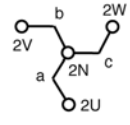
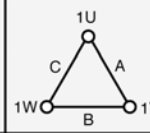
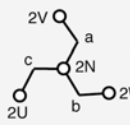
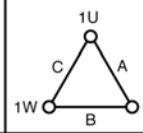
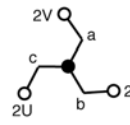
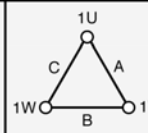
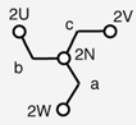
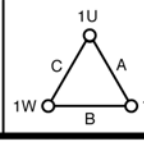
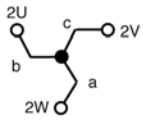
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
47			—	A	1U – 1V	2W – 2V	$\frac{U1}{U2}$	Dz2	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2U – 2W			
				C	1W – 1U	2V – 2U			
48			1V–1W 1W–1U 1U–1V	A	1U – 1V	2W – 2N	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn4	
				B	1V – 1W	2U – 2N			
				C	1W – 1U	2V – 2N			
49			—	A	1U – 1V	2W – 2U	$\frac{U1}{U2}$	Dz4	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2U – 2V			
				C	1W – 1U	2V – 2W			
9			—	A	1U – 1W	2U – 2W	$\frac{U1}{U2}$	Dz0	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2V – 2U			
				C	1W – 1V	2W – 2V			
10			—	A	1U – 1W	2W – 2U	$\frac{U1}{U2}$	Dz6	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
50			1V–1W 1W–1 U 1U–1V	A	1U – 1V	2N – 2U	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn6	
				B	1V – 1W	2N – 2V			
				C	1W – 1U	2N – 2W			
51			1V–1W 1W–1U 1U–1V	A	1U – 1V	2V – 2N	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn8	
				B	1V – 1W	2W – 2N			
				C	1W – 1U	2U – 2N			
52			—	A	1U– 1V	2V – 2W	$\frac{U1}{U2}$	Dz8	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2W – 2U			
				C	1W – 1U	2U – 2V			
53			1V–1W 1W–1U 1U–1V	A	1U – 1V	2N – 2W	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn10	
				B	1V – 1W	2N – 2U			
				C	1W – 1U	2N – 2V			
54			—	A	1U – 1V	2U – 2W	$\frac{U1}{U2}$	Dz10	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2V– 2U			
				C	1W –1U	2W – 2V			

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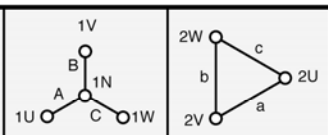
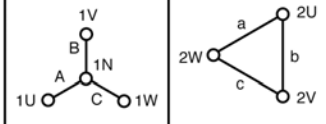
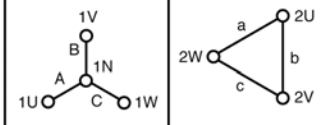
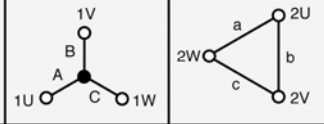
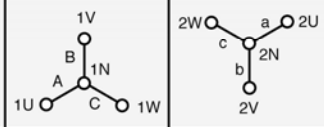
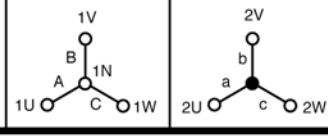
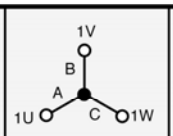
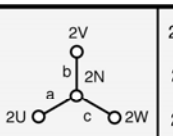
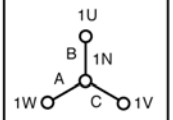
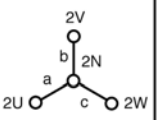
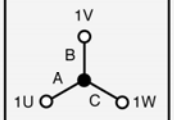
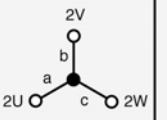
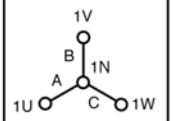
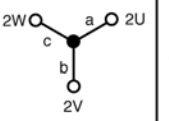
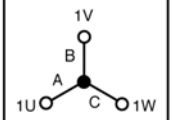
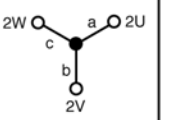
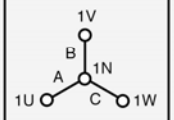
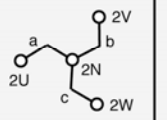
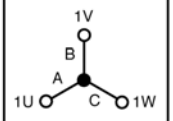
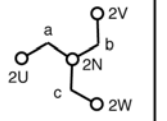
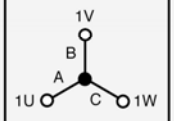
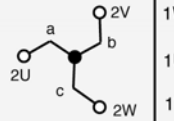
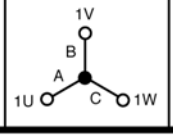
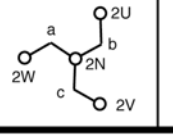
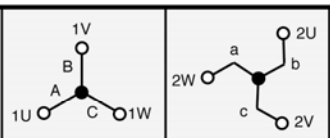
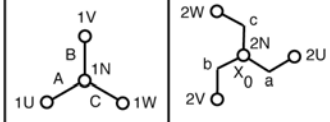
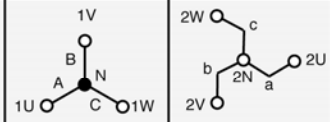
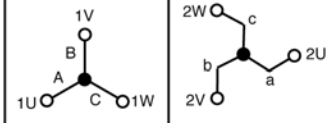
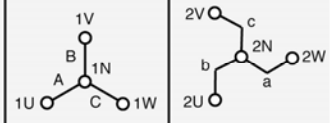
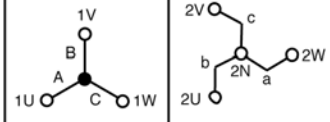
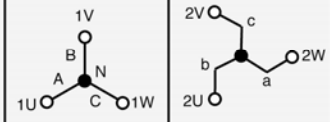
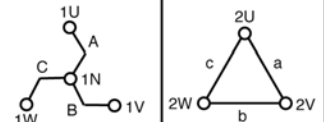
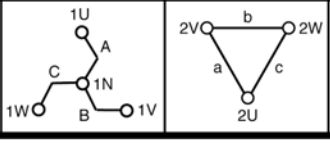
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
11			—	A	1U – 1N	2V – 2U	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd7	
				B	1V – 1N	2W – 2V			
				C	1W – 1N	2U – 2W			
44			—	A	1U – 1N	2U – 2V	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd1	
				B	1V – 1N	2V – 2W			
				C	1W – 1N	2W – 2U			
12			1W–1V 1U–1W 1V–1U	A	1U – 1W	2U – 2V	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2V – 2W			
				C	1W – 1V	2W – 2U			
13			—	A	1U– 1N	2W – 2U	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd5	
				B	1V – 1N	2U – 2V			
				C	1W – 1N	2V – 2W			
14			1W–1V 1U–1W 1V–1U	A	1U – 1W	2W – 2U	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
15			1W–1V 1U–1W 1V–1U	A	1U – 1W	2V – 2U	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2W – 2V			
				C	1W – 1V	2U – 2W			
16			—	A	1U– 1N	2U – 2W	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd11	
				B	1V – 1N	2V– 2U			
				C	1W – 1N	2W – 2V			
17			1W–1V 1U–1W 1V–1U	A	1U– 1W	2U – 2W	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2V – 2U			
				C	1W – 1V	2W – 2V			
18			—	A	1U – 1N	2N – 2U	$\frac{U1}{U2}$	YNyn6	
				B	1V – 1N	2N – 2V			
				C	1W – 1N	2N – 2W			
19			1V–1N 1W–1N 1U–1N	A	1U – 1N	2U – 2V	$\frac{U1}{U2}$	YNy0	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
				B	1V – 1N	2V – 2W			
				C	1W – 1N	2W – 2U			

CEI/IEC.050108C4

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
20			2W–2N 2U–2N 2V–2N	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2N 2V– 2N 2W – 2N	$\frac{U1}{U2}$	Yyn0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
43			—	A B C	1U – 1N 1V – 1N 1W – 1N	2U – 2W 2V – 2N 2W – 2N	$\frac{U1}{U2}$	YNyn0	
21			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2W 2V – 2U 2W – 2V	$\frac{U1}{U2}$	Yy0	NO ACCESSIBLE NEUTRAL
22			1V–1N 1W–1N 1U–1N	A B C	1U – 1N 1V – 1N 1W – 1N	2V – 2U 2W – 2V 2U – 2W	$\frac{U1}{U2}$	YNy6	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
23			2W–2N 2U–2N 2V–2N	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2U 2N – 2V 2N – 2W	$\frac{U1}{U2}$	Yyn6	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
24			—	A B C	1U – 1W 1V – 1U 1W – 1V	2W – 2U 2U – 2V 2V – 2W	$\frac{U1}{U2}$	Yy6	NO ACCESSIBLE NEUTRAL
65			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2N 2V – 2N 2W – 2N	$\frac{V_H \bullet \sqrt{3}}{V_X}$	YNzn1	
25			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2N 2V – 2N 2W – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Yzn1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
26			1W–1V 1U–1W 1V–1U	A B C	1U – 1W 1V– 1U 1W – 1V	2U – 2V 2V – 2W 2W – 2U	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yz1	NO ACCESSIBLE NEUTRAL
27			—	A B C	1U – 1W 1V – 1U 1W – 1V	2W – 2N 2U – 2N 2V – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Yzn5	NO ACCESSIBLE NEUTRAL ON WYE WINDING

CEI/IEC.050108C5

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			1W–1V 1U–1W 1V–1U	A B C	1U – 1W 1V – 1U 1W – 1V	2W – 2U 2U – 2V 2V – 2W	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2U 2N – 2V 2N – 2W	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{}$	YNzn7	
29			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2U 2N – 2V 2N – 2W	$\frac{U1 \bullet \sqrt{3}}{U2}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			1W–1V 1U–1W 1V–1U	A B C	1U– 1W 1V – 1U 1W – 1V	2V – 2U 2W – 2V 2U – 2W	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2W 2N – 2U 2N – 2V	$\frac{V_H \bullet \sqrt{3}}{V_X}$	YNzn11	
31			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2W 2N – 2U 2N – 2V	$\frac{U1 \bullet \sqrt{3}}{U2}$	Yzn11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			1W–1V 1U–1W 1V–1U	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2W 2V – 2U 2W – 2V	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			1V–1W 1W–1U 1U–1V	A B C	1U – 1N 1V – 1N 1W – 1N	2U– 2V 2V – 2W 2W – 2U	$\frac{2}{3} \bullet \frac{U1}{U2}$	ZNd0	
56			—	A B C	1U – 1V 1V – 1W 1W – 1U	2U – 2V 2V – 2W 2W – 2U	$\frac{U1}{U2}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			1V–1W 1W–1U 1U–1V	A B C	1U – 1N 1V – 1N 1W – 1N	2V – 2U 2W – 2V 2U – 2W	$\frac{2}{3} \bullet \frac{U1}{U2}$	ZNd6	

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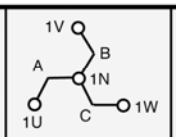
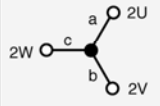
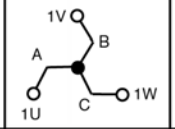
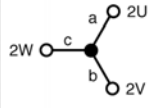
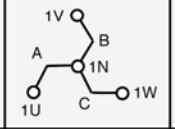
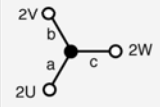
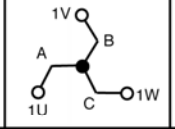
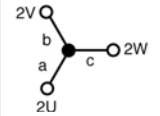
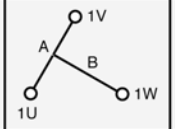
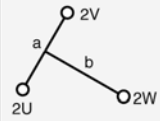
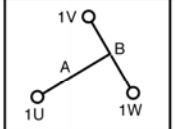
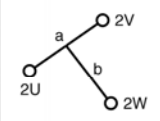
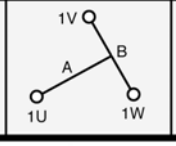
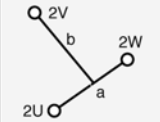
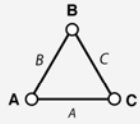
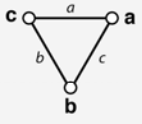
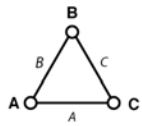
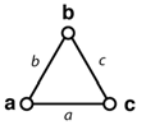
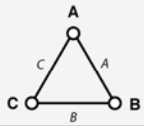
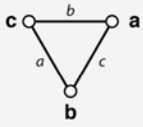
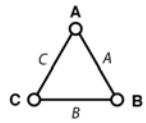
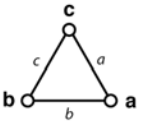
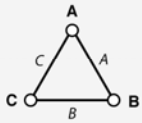
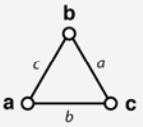
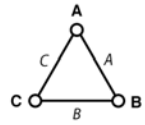
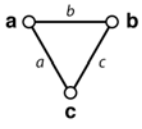
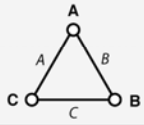
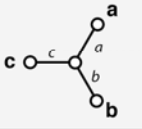
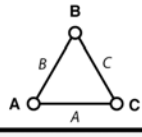
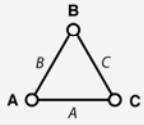
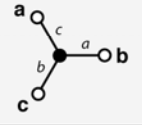
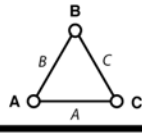
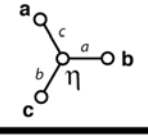
SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
33			—	A	1U – 1N	2W – 2U	$\frac{U1}{U2 \cdot \sqrt{3}}$	ZNy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1N	2U – 2V			
				C	1W – 1N	2V – 2W			
34			1W–1V 1U–1W 1V–1U	A	1U – 1W	2W – 2U	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	Zy5	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
35			—	A	1U – 1N	2U – 2W	$\frac{U1}{U2 \cdot \sqrt{3}}$	ZNy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1N	2V – 2U			
				C	1W – 1N	2W – 2V			
36			1W–1V 1U–1W 1V–1U	A	1U – 1W	2U – 2W	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	Zy11	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2V – 2U			
				C	1W – 1V	2W – 2V			
58			 1U–1V 2U–2V	A	1U – 1V	2U – 2V	$\frac{U1}{U2}$	T-T 0	
				B	1U – 1W	2U – 2W			
59			1V–1W 2U–2V	A	1U – 1W	2U – 2V	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	T-T 30 Lag	
				B	1V – 1W	2U – 2W	$\frac{U1}{U2} \cdot \frac{2}{\sqrt{3}}$		
60			1V–1W 2U–2W	A	1U – 1W	2U – 2W	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	T-T 30 Lead	
				B	1V – 1W	2V – 2U	$\frac{U1}{U2} \cdot \frac{2}{\sqrt{3}}$		

CEI/IEC.050108C7

APPENDIX D – Australian Std.2374 Transformer Descriptions

SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
1			—	A B C	A – C B – A C – B	c – a a – b b – c	HV / LV	Dd6	
37			—	A B C	A – C B – A C – B	a – c b – a c – b	HV / LV	Dd0	
38			—	A B C	A – B B – C C – A	c – b a – c b – a	HV / LV	Dd2	
39			—	A B C	A – B B – C C – A	c – a a – b b – c	HV / LV	Dd4	
40			—	A B C	A – B B – C C – A	b – c c – a a – b	HV / LV	Dd8	
41			—	A B C	A – B B – C C – A	a – c b – a c – b	HV / LV	Dd10	
42			—	A B C	A – C B – A C – B	a – η b – η c – η	HV • √3 / LV	Dyn1	
2			C – B A – C B – A	A B C	A – C B – A C – B	a – c b – a c – b	HV • √3 / LV	Dy1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
61			C – B A – C B – A	A B C	A – C B – A C – B	a – b b – c c – a	V_H • √3 / V_X	Dy3	NO ACCESSIBLE NEUTRAL ON WYE WINDING
62			—	A B C	A – C B – A C – B	η – b η – c η – a	HV • √3 / LV	Dyn3	

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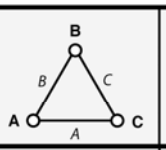
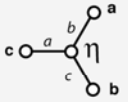
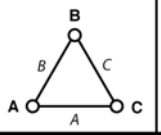
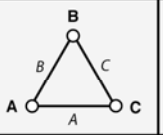
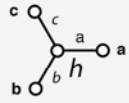
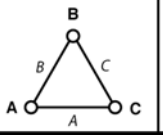
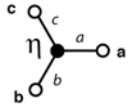
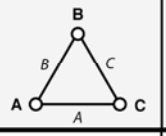
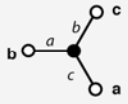
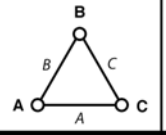
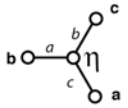
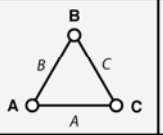
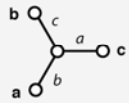
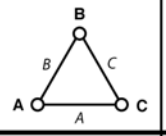
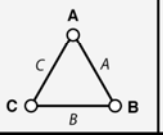
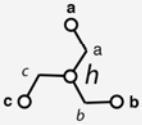
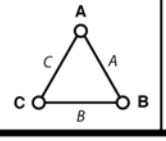
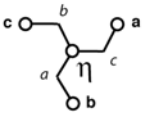
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
3			—	A	A – C	c – η	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn5	
				B	B – A	a – η			
				C	C – B	b – η			
4			C – B	A	A – C	c – b	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	a – c			
			B – A	C	C – B	b – a			
5			—	A	A – C	η – a	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn7	
				B	B – A	η – b			
				C	C – B	η – c			
6			C – B	A	A – C	c – a	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	a – b			
			B – A	C	C – B	b – c			
63			C – B	A	B – C	b – a	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy9	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	c – b			
			B – A	C	C – B	a – c			
64			—	A	A – C	b – η	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn9	
				B	B – A	c – η			
				C	C – B	a – η			
7			—	A	A – C	η – c	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn11	
				B	B – A	η – a			
				C	C – B	η – b			
8			C – B	A	A – C	b – c	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	c – a			
			B – A	C	C – B	a – b			
45			B – C	A	A – B	a – η	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn0	
			C – A	B	B – C	b – η			
			A – B	C	C – A	c – η			
46			B – C	C	A – B	η – b	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn2	
			C – A	A	B – C	η – c			
			A – B	B	C – A	η – a			

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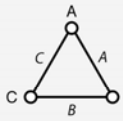
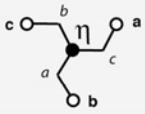
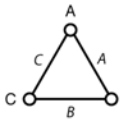
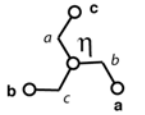
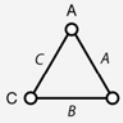
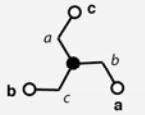
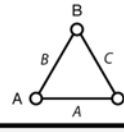
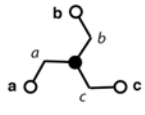
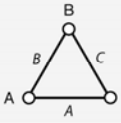
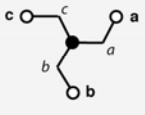
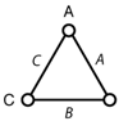
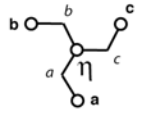
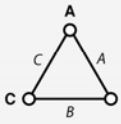
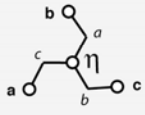
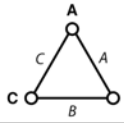
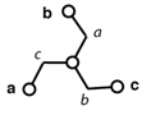
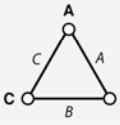
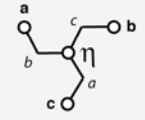
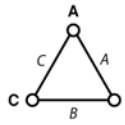
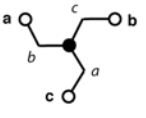
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
47			—	A B C	A – B B – C C – A	c – b a – c b – a	$\frac{HV}{LV}$	Dz2	NO ACCESSIBLE NEUTRAL
48			B – C C – A A – B	A B C	A – B B – C C – A	c – η a – η b – η	$\frac{3}{2}\bullet\frac{HV}{LV}$	Dzn4	
49			—	A B C	A – B B – C C – A	c – a a – b b – c	$\frac{HV}{LV}$	Dz4	NO ACCESSIBLE NEUTRAL
9			—	A B C	A – C B – A C – B	a – c b – a c – b	$\frac{HV}{LV}$	Dz0	NO ACCESSIBLE NEUTRAL
10			—	A B C	A – C B – A C – B	c – a a – b b – c	$\frac{HV}{LV}$	Dz6	NO ACCESSIBLE NEUTRAL
50			B – C C – A A – B	A B C	A – B B – C C – A	η – a η – b η – c	$\frac{3}{2}\bullet\frac{HV}{LV}$	Dzn6	
51			B – C C – A A – B	A B C	A – B B – C C – A	b – η c – η a – η	$\frac{3}{2}\bullet\frac{HV}{LV}$	Dzn8	
52			—	A B C	A – B B – C C – A	b – c c – a a – b	$\frac{HV}{LV}$	Dz8	NO ACCESSIBLE NEUTRAL
53			B – C C – A A – B	A B C	A – B B – C C – A	η – c η – a η – b	$\frac{3}{2}\bullet\frac{HV}{LV}$	Dzn10	
54			—	A B C	A – B B – C C – A	a – c b – a c – b	$\frac{HV}{LV}$	Dz10	NO ACCESSIBLE NEUTRAL

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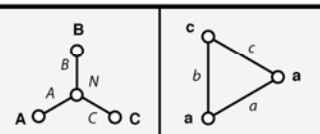
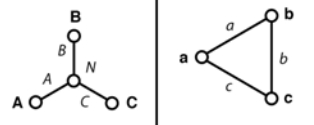
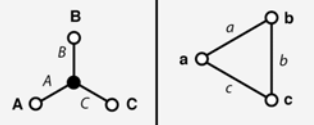
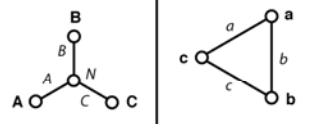
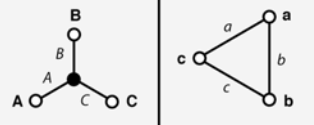
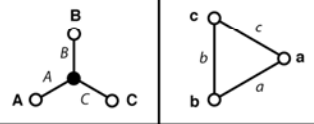
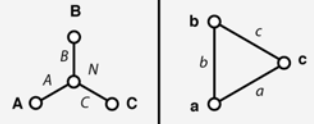
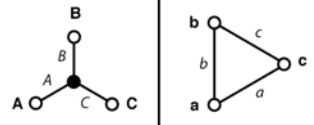
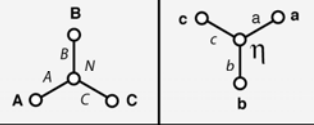
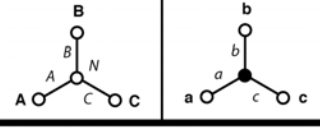
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
11			—	A B C	A – N B – N C – N	b – a c – b a – c	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd7	
44			—	A B C	A – N B – N C – N	a – b b – c c – a	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd1	
12			C – B A – C B – A	A B C	A – C B – A C – B	a – b b – c c – a	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
13			—	A B C	A – N B – N C – N	c – a a – b b – c	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd5	
14			C – B A – C B – A	A B C	A – C B – A C – B	c – a a – b b – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
15			C – B A – C B – A	A B C	A – C B – A C – B	b – a c – b a – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
16			—	A B C	A– N B – N C – N	a – c b – a c – b	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd11	
17			C – B A – C B – A	A B C	A – C B – A C – B	a – c b – a c – b	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
18			—	A B C	A – N B – N C – N	η – a η – b η – c	$\frac{HV}{LV}$	YNyn6	
19			B – N C – N A – N	A B C	A – N B – N C – N	a – b b – c c – a	$\frac{HV}{LV}$	YNy0	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING

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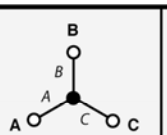
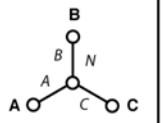
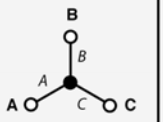
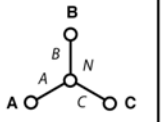
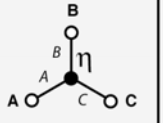
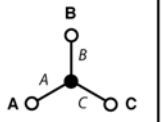
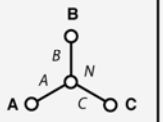
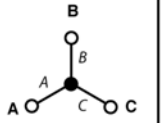
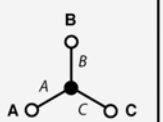
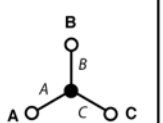
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
20			c – h a – h b – h	*A* *B* *C*	A – C B – C C – B	a – η b – η c – η	HV / LV	Yyn0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
43			—	*A* *B* *C*	A – N B – N C – N	a – η b – η c – η	HV / LV	YNyn0	
21			—	*A* *B* *C*	A – C B – A C – B	a – c b – a c – b	HV / LV	Yy0	NO ACCESSIBLE NEUTRAL
22			B – N C – N A – N	*A* *B* *C*	A – N B – N C – N	b – a c – b a – c	HV / LV	YNy6	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
23			c – h a – h b – h	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	HV / LV	Yyn6	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
24			—	*A* *B* *C*	A – C B – A C – B	c – a a – b b – c	HV / LV	Yy6	NO ACCESSIBLE NEUTRAL
65			—	*A* *B* *C*	A – C B – A C – B	a – η b – η c – η	$\frac{V_H \cdot \sqrt{3}}{V_X}$	YNzn1	
25			—	*A* *B* *C*	A – C B – A C – B	a – η b – η c – η	$\frac{V_H \cdot \sqrt{3}}{LV}$	Yzn1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
26			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	a – b b – c c – a	$\frac{HV}{LV} \cdot \frac{\sqrt{3}}{2}$	Yz1	NO ACCESSIBLE NEUTRAL
27			—	*A* *B* *C*	A – C B – A C – B	c – η a – η b – η	$\frac{HV \cdot \sqrt{3}}{LV}$	Yzn5	NO ACCESSIBLE NEUTRAL ON WYE WINDING

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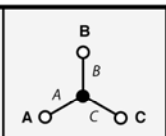
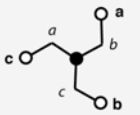
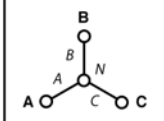
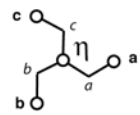
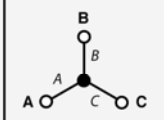
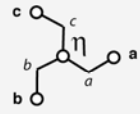
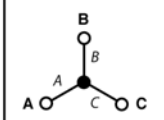
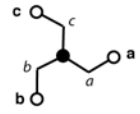
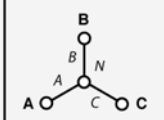
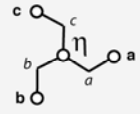
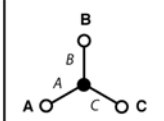
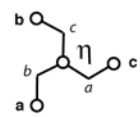
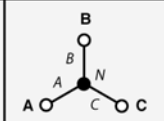
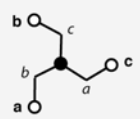
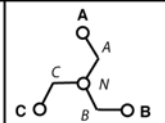
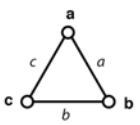
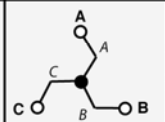
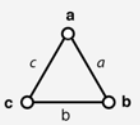
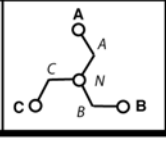
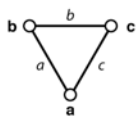
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	c – a a – b b – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{}$	YNzn7	
29			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{HV \bullet \sqrt{3}}{LV}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			C – B A – C B – A	*A* *B* *C*	A– C B – A C – B	b – a c – b a – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{V_H \bullet \sqrt{3}}{V_X}$	Yzn11	
31			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{HV \bullet \sqrt{3}}{LV}$	Yz11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	a – c b – a c – b	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	a – b b – c c – a	$\frac{2}{3} \bullet \frac{HV}{LV}$	ZNd0	
56			—	*A* *B* *C*	A – B B – C C – A	a – b b – c c – a	$\frac{HV}{LV}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	b – a c – b a – c	$\frac{HV}{LV}$	ZNd6	

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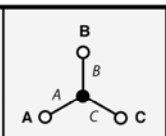
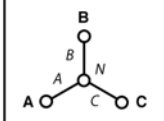
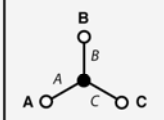
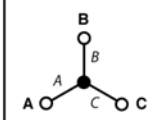
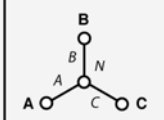
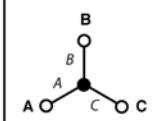
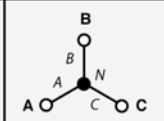
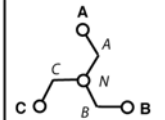
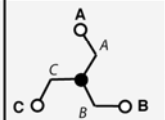
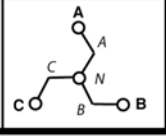
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	c – a a – b b – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{V_H}{V_X} \bullet \sqrt{3}$	YNzn7	
29			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{HV \bullet \sqrt{3}}{LV}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			C – B A – C B – A	*A* *B* *C*	A– C B – A C – B	b – a c – b a – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{V_H \bullet \sqrt{3}}{V_X}$	Yzn11	
31			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{HV \bullet \sqrt{3}}{LV}$	Yz11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	a – c b – a c – b	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	a – b b – c c – a	$\frac{2}{3} \bullet \frac{HV}{LV}$	ZNd0	
56			—	*A* *B* *C*	A – B B – C C – A	a – b b – c c – a	$\frac{HV}{LV}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	b – a c – b a – c	$\frac{HV}{LV}$	ZNd6	

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